

VOL. XXXVIII, No. 4, 1955

THE
MALAYAN
AGRICULTURAL JOURNAL

COMMONWEALTH INST.
ENTOMOLOGY LIBRARY
- 4 MAY 1956
SERIAL As.17
SEPARATE



PRINCIPAL CONTENTS

MINERAL NUTRITION OF THE OIL PALM BY J. K. COULTER, B.Sc. (HONS.),
B. AGR., DIP. AGR. SCI. (CAMB.), A.R.I.C., AND E. A. ROSENQUIST,
M.A., DIP. AGR. SCI. (CAMB.).

FURTHER INVESTIGATIONS INTO THE COMBINE HARVESTING OF WET PADI
BY D. W. M. HAYNES, B.Sc., A.M.I.B.A.E.

CULTIVATION OF FODDER GRASSES IN MALAYA. PART III. THE TIME AND
FREQUENCY OF APPLICATION OF FERTILISERS BY R. HENDERSON,
M.C., B.Sc.

A MANILA HEMP VARIETY TRIAL BY J. S. URE, B.Sc., D.T.A.

NOTES ON CURRENT INVESTIGATIONS, JULY TO SEPTEMBER, 1955.

MECHANISATION. HALF-YEARLY REPORT, APRIL TO SEPTEMBER, 1955.

NOTES ON EXTENSION WORK, JULY TO SEPTEMBER, 1955.

DEPARTMENT OF AGRICULTURE, FEDERATION OF MALAYA.

Kuala Lumpur.

PRICE \$2

DEPARTMENT OF AGRICULTURE, FEDERATION OF MALAYA.

ORGANIZATION (as at 31st October, 1955).

Director of Agriculture:—R. G. Heath, B.Sc. (Agr.), A.I.C.T.A.

Deputy Director of Agriculture:—J. Cook, B.Sc. (Hons.), A.I.C.T.A. (*Acting*).

Administrative Officer:—H. F. Logan.

Office Assistant:—Low Kim Ann.

Financial Assistant:—V. Sundram.

RESEARCH BRANCH.

Chief Research Officer:—

R. B. Jagoe, B.Sc. (Hons.). (*On leave*).

L. N. H. Larter. (*Acting*).

(II) BOTANY.

Senior Botanist:—

L. N. H. Larter, B.Sc. (Hons.), A.R.C.S.,
A.I.C.T.A.

F. B. Brown. (*Acting*).

Plant Breeders:—

F. B. Brown, B.Sc. (Hons.), Dip. Agr. Sci.
(Camb.).

A. V. Haddon, B.Sc. (Hons.), Dip. Agr. Sci.
(Camb.).

Chew Hong Jung, B.Sc. (Hons.), B. Agric.

Van Thean Kee, B.Sc. (Hons.).

One vacancy.

Plant Physiologists:—

J. Dore, B.Sc. (Hons.), Ph.D., A.R.C.S.

* R. G. Lockard, B.S.A., M.Sc. (Agric.).

Asst. Research Officer:—

Tak bin Haji Daud.

(III) CHEMISTRY.

Senior Chemist:—

A. E. Billington, M.A., A.R.I.C.

Canning Officer:—

F. N. G. Conaty, B.Sc., A.R.I.C.

Chemists:—

K. Kanapathy, M.Sc. (Adelaide).

Miss M. Smith, B.Sc. (*Temporary*).

Assistant Chemist:—

Kao Wei Tsan, B.Sc. (Lingnan).

(IV) SOIL SCIENCE.

Senior Chemist (Soils):—(*Vacant*).

A. R. McWalter. (*Acting*).

FIELD BRANCH.

Chief Field Officer:—

J. R. Curry, Dip. Agr. Sci. (Dunelm), N.D.A.
(*On leave*).

H. J. Simpson, P.J.K., B.Sc. (Agr.). (*Acting*).

Agricultural Economist:—

T. B. Wilson, B.A. (Oxon), Dip. Agric. Econ.,
D.T.A.

Personal Assistant to Chief Field Officer:—

Yoon Weng Kong.

KEDAH & PERLIS: *State Agricultural Officer (Kedah
and Perlis)*:—

E. J. H. Berwick, M.A., Dip. Agric. Sci.
(Camb.), A.I.C.T.A.

Agricultural Officer:—

M. G. Hawson, B.Sc. (Agric.), D.T.A.

Asst. Agricultural Officers:—

Hj. Mohd. Salleh bin Musa.

Salim bin Mhd. Akib.

Abdul Hamid bin Haji Hussain (*Perlis*).

KELANTAN: *State Agricultural Officer*:—

P. G. Coleman, M.A., A.I.C.T.A. (*Acting*).

Asst. Agricultural Officer:—

Hj. Mahmud bin Haji Yaacob.

TRENGGANU: *State Agricultural Officer*:—

J. L. B. Hitchcock, B.Sc. (Dunelm).

Asst. Agricultural Officer:—(*Vacant*).

PENANG & PROVINCE WELLESLEY: *Settlement*

Agricultural Officer:—

J. R. Milburn, B.Sc. (Dunelm), D.T.A.

Asst. Agricultural Officer:—

Mohd. Noordin bin Mohd. Kassim.

PERAK: *State Agricultural Officer*:—

W. N. Scott, B.Sc., B. Agr., Ph.D., D.I.C.

Agricultural Officer:—

Perak North—Ahmad bin Mhd Amin,
B.Sc. (Agric.).

THE
Malayan Agricultural Journal

Edited by the Publications Officer with the assistance of
The Publications Committee.

Vol. XXXVIII

No. 4, 1955.

EDITORIAL	213
-------------------	-----

ORIGINAL ARTICLES.

MINERAL NUTRITION OF THE OIL PALM BY J. K. COULTER, B.Sc. (HONS.), B.AGR., DIP. AGR. SCI. (CAMB.), A.R.I.C., AND E. A. ROSENQUIST, M. A., DIP. AGR. SCI. (CAMB.) ..	214
FURTHER INVESTIGATIONS INTO THE USE OF SELF-PROPELLED COMBINE HARVESTERS FOR THE HARVESTING OF WET PADI IN THE NORTH KEDAH PLAIN BY D. W. M. HAYNES, B.Sc., A.M.I.B.A.E.	237
THE CULTIVATION OF FODDER GRASSES IN MALAYA. PART III. THE TIME AND FREQUENCY OF APPLICATION OF FERTILISERS BY R. HENDERSON, M.C., B.Sc.	250
MANILA HEMP. A VARIETY TRIAL AT THE FEDERAL EXPERIMENT STATION, SERDANG, BY J. S. URE, B.Sc., D.T.A. ..	256
NOTES ON CURRENT INVESTIGATIONS, JULY TO SEPTEMBER, 1955:-	
RESEARCH	262
AGRONOMY	268
MECHANISATION. HALF-YEARLY REPORT, APRIL TO SEPTEMBER, 1955	273
NOTES ON EXTENSION WORK, JULY TO SEPTEMBER, 1955 ..	276

REVIEW.

DIRECTORY OF WHEEL AND TRACK-TYPE TRACTORS PRODUCED THROUGHOUT THE WORLD	288
--	-----

DEPARTMENTAL.

DEPARTMENTAL NOTES	289
----------------------------	-----

STATISTICAL.

MARKET PRICES, JULY TO SEPTEMBER, 1955	290
PRODUCTION OF PALM OIL AND KERNELS, FEDERATION OF MALAYA ..	292
MALAYAN AGRICULTURAL EXPORTS, APRIL TO JUNE, 1955 ..	292
RUBBER PRODUCTION, FEDERATION OF MALAYA	293
COPRA, COCONUT OIL AND COPRA CAKE PRODUCTION, FEDERATION OF MALAYA	294
RICE STATISTICS, FEDERATION OF MALAYA, 1954-55 SEASON ..	295
METEOROLOGICAL SUMMARY, JUNE, 1955	298
METEOROLOGICAL SUMMARY, JULY, 1955	299
METEOROLOGICAL SUMMARY, AUGUST, 1955	300

THE MALAYAN AGRICULTURAL JOURNAL

The Journal is designed to present—as far as possible in non-technical terms—the results of the agricultural research, investigation and extension work in Malaya performed by the Department of Agriculture. Also, by means of selected articles, abstracts and reviews, this publication draws attention to the results of work of a similar nature in other countries, which have a bearing on agriculture in Malaya.

The Department of Agriculture does not necessarily recommend the use of any product advertised in the Journal by commercial firms.

The Journal is published quarterly.

PRICE \$2 PER COPY OR \$8 PER ANNUM, POST FREE IN MALAYA; \$8.50 OR £1 STERLING, POST FREE OUTSIDE MALAYA.

Publications may be obtained from the Department of Agriculture, Kuala Lumpur, Federation of Malaya, or from the Office of the Commissioner for Malaya in the United Kingdom, 57, Trafalgar Square, London, W.C.2.

A remittance to cover cost should accompany application for publications. Malayan currency \$1 = 2s. 4d.

COMMITTEES OF THE DEPARTMENT

Standing Committee on Investigations.

The Deputy Director of Agriculture. (*Chairman*).
The Chief Research Officer.
The Chief Field Officer.
The Senior Agronomist.
The State Agricultural Officer, Selangor.
The Agronomist-in-Charge, Federal Experiment Station, Serdang.
The Publications Officer. (*Secretary*).

The Publications Committee.

The Director of Agriculture, Federation of Malaya. (*Chairman*).
The Deputy Director of Agriculture.
The Chief Field Officer.
The Chief Research Officer.
The Senior Agronomist.
The Publications Officer. (*Secretary*).

Examinations Board.

The Deputy Director of Agriculture. (*Chairman*).
The Chief Field Officer.
The Chief Research Officer.
The Senior Agronomist.
The Principal, College of Agriculture, Malaya.

The Advisory Council, College of Agriculture, Malaya.

The Director of Agriculture, Federation of Malaya. (*Chairman*).
The Director, Rubber Research Institute of Malaya, Kuala Lumpur.
The Principal, Sultan Idris Training College, Tanjong Malim.
The Principal, College of Agriculture, Malaya.
The Director, Veterinary Services, Federation of Malaya.
The Hon'ble Che Hashim bin Awang, J.P., Tassek Glugor.
Secretary of the Alumni Association, College of Agriculture, Malaya.
The Hon'ble. Mr. Yap Kim Hock, Johore Bahru.
Dato Kamal Wangsa, O.B.E., Kuala Trengganu.
Mr. Gunn Lay Teik, O.B.E., Kuala Lumpur.
Enche Jamaludin bin Aji, Seremban.
Enche Senu bin Abdul Rahman, Kuala Lumpur.
The Representative of the Rubber Producers Council.
The Registrar and Bursar. (*Secretary*).

THE Malayan Agricultural Journal

Vol. 38, No. 4, 1955.

EDITORIAL.

Leaf "Bronzing" of Oil Palms. In the first article in this issue of the Journal, Messrs. Coulter and Rosenquist report their findings in the latest completed investigation of the problem of "bronzing" of oil palm leaves.

The authors divide the "bronzing" disorder into the two deficiency symptoms "orange spotting" and "yellowing", the former being connected with an incomplete supply of potassium and a high calcium content in the fronds, and "yellowing" with the magnesium content of the frond.

The investigations were carried out on palms of five different families growing on a sandy loam at the Federal Experiment Station, Serdang.

Combine Harvesting of Padi. An article by Mr. Haynes describes the second series of trials with a combine harvester on a padi crop in Kedah.

The trials were interesting but somewhat disappointing for whereas a similar machine would be expected to harvest 200 acres of dry-land cereals in the United Kingdom, in Kedah it dealt with only 19.1 acres. Admittedly considerable time was lost through major breakdowns, but even allowing for this and for more favourable conditions, i.e. larger fields all in one locality and double-shift working; it is doubtful whether the machine would harvest more than 100 acres in a season.

It is obvious that combine harvesters cannot be superimposed economically on peasant farming; they are, however, likely to be much more efficient on special farms laid out for mechanisation.

As a pointer to the future, it should be noted that plant-breeders in western countries have evolved special "combine" types of temperate cereals with short, stiff straw. The Department already has one such variety of padi and this can be expected to figure prominently in future mechanised harvesting trials.

The Cultivation of Fodder Grasses. The third and last part of Mr. Henderson's article appears on later pages and describes a trial with Guinea grass the results of which suggest that a uniform growth of grass over a year may be obtained by applying fertilisers shortly after every harvest. In addition, mention is made of another experiment which confirms that the use of fertilisers has its greatest effect on the yield of Guinea grass at the first harvest after application.

Manila Hemp. A short article by Mr. Ure describes a Manila hemp variety trial carried out at Serdang in which the three recognised varieties introduced from the Philippine Islands and three genotypes of a hybrid population of local origin were compared.

A New Classified Index to the Journal. A new classified index to the Journal will become available early in 1956. The index covers the years 1912 to 1954 and is issued free to subscribers to the Journal. Applications for copies of the index should be made to the Editor.

MINERAL NUTRITION OF THE OIL PALM

A Study of the Chemical Composition of the Frond in Relation to Chlorosis and Yield.

BY

J. K. COULTER,

Acting Senior Chemist (Soils),

and

E. A. ROSENQUIST,

Formerly Botanist of the Department of Agriculture

Introduction.

Leaf "bronzing" has been a problem of oil palms in Malaya for many years, and has been notable at the Federal Experiment Station, Serdang, where manurial experiments were in progress up to 1941, when work had to be abandoned. In these experiments, the only indication of a favourable response to manuring was appearing in Field 21 from a dressing of *patent kali* (a potassium-magnesium salt). Subsequently, in 1948, "bronzing" of fronds was noted in replicated, "selfed", young oil palm families in Field 4. Particular interest was aroused as there were marked differences in the amount and degree of "bronzing" between the families, and therefore clear evidence of genetical differences in susceptibility to "bronzing". The replicated "selfed" progenies provided material of particular value with which to initiate and carry out further investigations.

These "selfed" progenies of individual oil palms selected on Elmina Estate, Selangor, were planted at the Federal Experiment Station, Serdang, from 1937 to 1940. Five of the progenies were planted in replicated rows in 1939, and it was amongst these families that the particular discolouration differences were noted. Of these, the fronds of E.268 and E.216 were mainly a healthy green in appearance; E.152 was slightly affected; and E.207 and E.97 were fairly severely affected by "bronzing". As these families of oil palms were planted in rows of 10 to 12 palms, arranged in six randomised blocks, there was ample scope for investigation of their nutrition, particularly as it affected the composition of the frond.

Physiological disorders leading to chlorosis and necrosis of the foliage of the oil palm have been noted by Hale (7) in Nigeria, who distinguished two conditions known as "speckled bronzing" and "lemon" frond, and put forward a tentative suggestion that "speckled bronzing" is due to potassium deficiency.

Ferrand, Bachy and Ollagnier (6) showed that, on coarse, sandy soils in Africa, additions of trace elements, including copper, zinc, manganese, iron, boron, and also magnesium, increased yields and improved the health of the palms which were yellowed and necrotic. In West Africa, also, Bull

(2) has described a condition due to magnesium deficiency as "orange frond disease". This is similar to the "yellowing" which is discussed in this paper. He states that an application of 10 lb. magnesium sulphate per palm cured the disease in nine months, though yields did not increase within the same period. Further confirmation that "orange frond" was due to magnesium deficiency comes from the finding that injection of diseased leaflets on young palms with solutions of magnesium cured the disease in 19 days (12).

The work described here, for the oil palms in Field 4 at the Federal Experiment Station, Serdang, covers the period March, 1952, to June, 1953. A method of scoring for "orange spotting" and "yellowing" is given, and correlation of these scores with yield, chemical composition of the frond, and selfed progenies is discussed. The change in chemical composition of the frond with age, for different progenies, with healthy and chlorotic palms is also given.

Definition of the Components of "Bronzing".

Oil palm frond discolouration which has been referred to as "bronzing" is now defined in terms of two types of discolouration, namely "orange spotting" and "yellowing". These two types of frond discolouration are described as follows:-

(i) *Orange Spotting.*

Clearly defined orange spots form on the pinnae of the older fronds and gradually enlarge. The spots are irregular in shape, but tend to follow the venation of the pinnae. In size, they vary from $1/16$ to $1/4$ in. or larger. The intervening areas of the pinnae remain a normal green. The frequency and size of the spots increases with the age of the frond. Necrosis may start at the middle or end of the spots or at the edge of the pinnae. This necrosis may spread until, finally, the entire pinnae die. It is thought that the onset of necrosis is associated with an invasion of *Pestalozzia* but that this is purely secondary. Necrosis is not as severe as in "yellowing".

(ii) *Yellowing.*

The pinnae of the older fronds become yellow. The "yellowing" is general over the pinnae, but is most marked at the ends and edges. There is no indication of any spotting. In each frond there is an upper and lower rank of pinnae, and the upper rank is in general more severely yellowed than the lower rank. Necrosis almost invariably starts from the tips and edges of the pinnae and spreads rapidly until the pinnae die. Again, the necrosis is thought to be due to an invasion of *Pestalozzia*, which is a secondary effect of the "yellowing".

Both of these frond discolouration symptoms are common on the oil palms at the Federal Experiment Station, Serdang, and the above terms have been adopted for discussing them. In March, 1952, "yellowing" was not severe, but by early 1954 it was much more conspicuous. The degree of "orange spotting" increased slightly during the same period. Plate I is a colour illustration showing typical forms of the two conditions of chlorosis, though, of course, they often occur together.

Chlorosis in Relation to Yields.

In June, 1953, a scoring system was started, and six observers made separate scores for "orange spotting" and "yellowing" for all palms in the trial. The observers worked independently and from different sides of the field. Although their standards varied, there was good agreement between observers. The scores of six observers were totalled and thus each individual palm was given an "orange spotting" score and a "yellowing" score.

The method of scoring used was 10 to 1 in favour of healthy appearance of leaves, but this was not a suitable one for representing correlations of ("orange spotted" and "yellowed") discoloured fronds with mineral deficiencies and yields, and it has been converted to a scale of 0 to 9 in direct relationship to the degree of discolouration. Having allocated each palm a score for "yellowing" and one for "orange spotting", Table I was prepared.

The negative correlation between yield (over the preceding five years) and "orange spotting" score is highly significant in each family. It is obvious that palms which are "orange spotted" give low yields. The regression of yield on "orange spotting" is also significant and appears to be greater in the relatively healthy families.

The negative correlation between yield and "yellowing" score is significant in two families (E.216 and E.152). It appears that, under the conditions of this trial, "yellowing" is not coincident with depressed yield to the same extent as "orange spotting" is, at least at this particular time.

Finally, in four families, there is no suggestion of a correlation (either positive or negative) between "orange spotting" score and "yellowing" score. It thus appears that the two conditions are unrelated. In one family (E.216) however, there is a highly positive correlation between "orange spotting" and "yellowing" scores. The reason for this apparent abnormality is not yet known.

Chlorosis in Relation to Leaf Composition.

In recent years the chemical composition of the oil palm frond has received increasing attention as a means of studying its nutrition and investigating physiological diseases of the palm (1, 4, 7, 9, 10). However, the use of foliar diagnosis, based on leaf analyses, is subject to certain limitations which must be taken into account.

Elgabaly (5) has put forward the following criteria to be considered:-

- (a) plants may vary greatly in internal composition without a corresponding change in yield;

- (b) in cases of "luxury consumption", plants may continue to accumulate more of certain nutrients than is required for maximum growth and yield; and
- (c) nutrient uptake by plants is governed by all environmental factors.

Table I.

Correlation and Regression Coefficients between Yields, "Orange Spotting" and "Yellowing", Based on Individual Palms within Families.

Family ..	E. 268	E. 216	E. 207	E. 152	E. 97	M.S.D.
No. of palms ..	57	57	62	46	60	
Yield per palm per annum (1946-52) in lb. of fruit bunches ..	215	193	141	152	131	27
"Orange spotting" score ..	42	60	160	75	159	27
"Yellowing" score ..	74	95	63	118	127	23
r, yield and "orange spotting" ..	*** -.416	*** -.416	*** -.541	** -.388	*** -.556	
r, yield and "yellowing" ..	-.219	* -.304	+155	* -.449	-.067	
r, "orange spotting" and "yellowing" ..	+089	*** +.457	+210	+006	-.152	
b, yield and "orange spotting" ..	** -4.335	** -5.696	*** -2.560	** -3.520	*** -3.754	
b, yield and "yellowing" ..	-1.842	-3.398	+1.520	-5.041	-.526	

Six observers scored each palm for "orange spotting" or "yellowing", and scores are recorded on a scale of 0 to 9.

The score given is the total of the mean of six plots (max. score 324).

r = Correlation Coefficient.

b = Regression Coefficient.

* = Significant at P.05.

** = Significant at P.01.

*** = Significant at P.001.

M.S.D. = Minimum for Significant Difference at P.05.

Not only is the total supply of plant nutrients in the soil of great importance but their ratio to one another is of equal importance and is one of the factors considered in our discussion. A low original content of one element in the leaf may be depressed even lower by the addition of other nutrients to the soil, and may thus lead to symptoms of deficiency. In soils low in magnesium, this may be caused by potassium applications, and the potassium is then said to bring about magnesium deficiency. Numerous other examples of this type of effect have been recorded, and they come under the general title of "antagonisms". The opposite effects, synergisms, are more difficult to understand.

Prevot and Ollagnier (9) in their work on oil palms have shown the existence of potassium-calcium and potassium-magnesium "antagonisms" and a calcium-magnesium synergism. There is also a close relationship between N and P. They worked out the ten possible correlations between pairs of the elements N, P, K, Ca and Mg and showed that the N/P ratio is surprisingly constant in the oil palm. They also showed that calcium, magnesium and potassium are linked together and that correlations between K and Ca or K and Mg are negative while those between Mg and Ca are positive. They propose a broad basis of classification of the nutrients in the leaf. Nitrogen and phosphorus could be termed the protoplasmic class and the other elements the basic elements class. Prevot and Ollagnier showed that the sum of the percentages of K, Ca and Mg in the dry matter of the frond have a fairly constant value of a little over 2.

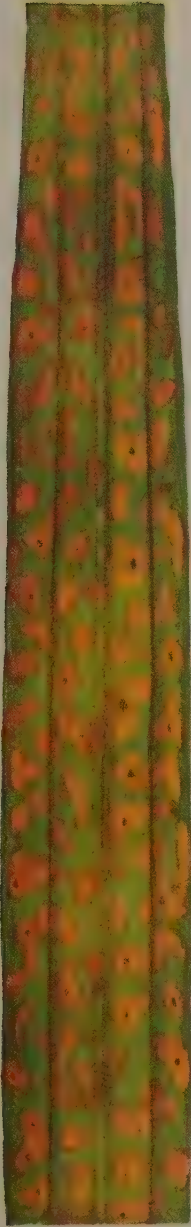
Chapman and Gray (4) noted that in certain circumstances manuring with potassium increases the leaf nitrogen, and that in cases where potassium was lacking or non-available, e.g. in peat soils, manuring with phosphate decreased yields.

Analyses of Serdang Palms.

Chemical analysis of frond 3 of five different progenies was started in March, 1952. Frond 3 was chosen as it is the youngest, fully opened frond. Early morning was the time chosen for sampling. Six months later, i.e. September, 1952, analysis of frond 17 was started, and the sampling of the two fronds done at the same time. Pinnae from the middle of these, including the mid-rib, were chopped up, oven dried and ground for analyses. Nitrogen was determined by the Kjeldahl method on the oven dry material; calcium, potassium, phosphorus and magnesium were determined on the ash, which was obtained by heating at 300°C for three hours and then slowly raising the temperature to 550°C until ashing was complete.

In the tables, the figures given are mostly based on the mean values for three or four analyses. This may have masked some important seasonal

PLATE I.



Orange Spotting



Yellowing

Two types of chlorosis in oil palm pinnae.

78

variations, but has reduced variability and increased the statistical significance of the results.

It will be noted that in the tables two headings are used, "Treatment A" and "Treatment B". This is because preliminary analyses indicated low potassium-calcium ratios in Serdang palms and it was thought that the calcium in the rock phosphate, which was being applied to all palms, was responsible for this, and that the consequent low potassium uptake might be the cause of "bronzing". Accordingly, in April, 1952, five blocks of these rows of "selfed" progenies were used to carry out a "split plot" experiment in which Treatment A contained calcium in the form of Christmas Island rock phosphate, while Treatment B did not, the rock phosphate being replaced by mono-ammonium phosphate. The rates per palm were:- 2 lb. ammonium sulphate; 4 lb. Christmas Island rock phosphate, or its equivalent of mono-ammonium phosphate in Treatment B; 4 lb. muriate of potash; and 1 lb. magnesium sulphate; while for Treatment B, the ammonium sulphate was reduced to allow for the nitrogen in $2\frac{1}{2}$ lb. mono-ammonium phosphate. The amounts of N, P, K, and Mg supplied in both treatments were the same. The 4 lb. of muriate of potash was given half-yearly, in 2 lb. dressings, in April and October.

EXPRESSION OF RESULTS.

The conventional method of setting out the results of analyses is to express them as oxides, e.g. K_2O , P_2O_5 etc. Some workers, however, express them as the elements, e.g. K, P, etc. Prevot and Ollagnier (8 and 9) use the latter method, as does Broeshart (1), while Chapman and Gray (4) and Hale (7) use the former. A more debatable point is whether to express the results as a percentage of dry matter or as a percentage of ash. Chapman and Gray quote Thomas (11) as stating that the ash constituents should be expressed as a percentage of dry matter, because their concentration in the leaf determines growth. They conclude, however, that until more is known concerning the nature of the absorption and to what extent some of the ash constituents may contribute to the absorption of others, it cannot be concluded that either method of expression gives the better indication of their effective concentration in the leaf. Chapman and Gray (4) state that a preliminary survey showed that the variation in ash percentage was seldom sufficient to give a significant difference between the two methods of expression.

Our results do not agree with this. In Table II (a), the correlations between percentages of K_2O , CaO , MgO and P_2O_5 on ash and the percentage ash are calculated. Table II (b) gives the correlations when the analyses are expressed as percentages of dry matter.

If the correlations between K_2O , CaO , MgO and P_2O_5 with ash were the same in each case, it would make no difference whether results were expressed on ash or on dry matter. In fact, however, the correlations are markedly different. The P_2O_5 with ash correlation is highly significant in

Table II.

Correlation Coefficients between Percentage P_2O_5 , K_2O , CaO and ash *inter se*.

(Each coefficient based on samples from 25 plots of four palms each)

(a) Results Expressed on Ash.

Frond No.		Treatment A. Fertilisers with Calcium				Treatment B. Fertilisers without Calcium			
		K_2O	CaO	MgO	P_2O_5	K_2O	CaO	MgO	P_2O_5
3	K_2O	—	*** -0.660	-0.352	-0.062	—	** -0.591	-0.330	-0.131
	CaO	—	—	+0.228	+0.359	—	—	+0.271	** +0.581
	MgO	—	—	—	+0.168	—	—	—	+0.209
	Ash	-0.356	-0.143	-0.126	*** -0.719	-0.211	-0.187	-0.257	** -0.513
17	K_2O	—	+0.029	+0.097	** +0.557	—	+0.124	-0.358	+0.299
	CaO	—	—	** +0.514	*** +0.784	—	—	*** +0.598	+0.796
	MgO	—	—	—	* +0.477	—	—	—	* +0.478
	Ash	** -0.546	*** -0.770	** -0.568	*** -0.935	-0.044	*** -0.851	* -0.438	-0.342

(b) Results Expressed on Dry Matter.

Frond No.		Treatment A				Treatment B			
		K_2O	CaO	MgO	P_2O_5	K_2O	CaO	MgO	P_2O_5
3	K_2O	—	-0.238	+0.018	+0.058	—	-0.206	-0.158	+0.088
	CaO	—	—	* +0.415	** +0.529	—	—	+0.343	***
	MgO	—	—	—	+0.374	—	—	—	+0.232
17	K_2O	—	*** -0.735	** -0.574	+0.200	—	** -0.606	** -0.549	+0.192
	CaO	—	—	+0.249	+0.027	—	—	* +0.467	-0.003
	MgO	—	—	—	-0.161	—	—	—	+0.259

* = Significance P.05 = .397 in all cases.

** = Significance P.01 = .507 in all cases.

*** = Significance P.001 = .620 in all cases.

both fronds 3 and 17. The CaO with ash and MgO with ash correlations are not significant in frond 3, but are significant in frond 17.

Comparison of Tables II (a) and II (b) shows that the relation between the various ash constituents differs according to the method of expression. For example, there is a significant negative correlation between K_2O and CaO in frond 3 when the results are expressed as percentage ash, but this disappears if the results are expressed as percentage leaf dry matter.

This, unfortunately, complicates the interpretation of the results, but for the sake of simplicity the percentage nutrient in ash has been chosen as the basis of discussion. This has the advantage that variations in the effectiveness of ashing do not influence the results to such an extent. Reference is made to cases where expression on a dry-matter basis gives a different interpretation.

DISCUSSION OF RESULTS.

Table III shows correlations between "yellowing", "orange spotting" and chemical composition of pinnae from affected trees; they have been worked out on the same basis as those shown for "orange spotting", "yellowing" and yield, i.e. using the same scores.

The results may be summarised as follows:-

(i) "*Yellowing*".

There is a highly significant negative correlation between "yellowing" score and percentage MgO in frond 17 expressed on ash or dry matter basis. In frond 3, the correlation is also negative and almost achieves significance on ash basis. These correlations would point to the fact that "yellowing" is closely associated with and probably caused by magnesium deficiency. In support of this contention, it has been shown that painting yellowed pinnae with a 2 per cent solution of magnesium sulphate causes the pinnae to become green again, although the response is rather slow. The positive correlation of "yellowing" and K_2O percentage is also interesting.

(ii) "*Orange Spotting*".

There is a negative correlation between "orange spotting" and K_2O in frond 3 and a positive correlation between "orange spotting" and CaO in frond 3. These results point to the conclusion that "orange spotting" is associated with deficient potassium and excess calcium. There are no significant correlations between "orange spotting" and any of the ash constituents in frond 17.

(iii) *Yield*.

As was shown in Table I, yield is negatively correlated with "orange spotting", and it is therefore not surprising that there

Table III.

Correlation Coefficients between Nutrient Percentages,
 "Orange Spotting" Scores, and "Yellowing" Scores.

(Each coefficient based on samples from 25 plots of four palms each)

(a) Results Expressed on Ash.

Fron No.		Treatment A. Fertilisers with Calcium					Treatment B. Fertilisers without Calcium				
		K ₂ O	CaO	MgO	P ₂ O ₅	Ash	K ₂ O	CaO	MgO	P ₂ O ₅	Ash
3	Orange Spotting	** -566	** +534				*** -640				
				-.019	+.216	+.064		+.295	+.222	+.096	-.126
	Yell-owing										
		-268	+.037	-.386	-.325	+.621	+.007	-.064	-.327	-.270	+.108
	Yield	*** +.715	* -.430				* +.457	** -.613			
				+.045	-.126	-.266		-.164	-.322		-.111
17	Orange Spotting										
		+.289	-.041	-.287	+.260	-.119	-.066	+.085	-.112	+.223	-.120
	Yell-owing										
		-.229	-.397	*** -.724	* -.507	** +.614	* +.412	* -.443	** -.621		+.333
	Yield	+.002	+.084	+.333	-.055	-.075	-.396	-.200	+.225	-.169	+.146

(b) Results Expressed on Dry Matter.

Fron No.		Treatment A				Treatment B			
		K ₂ O	CaO	MgO	P ₂ O ₅	K ₂ O	CaO	MgO	P ₂ O ₅
3	Orange Spotting	* -.460	* +.505			*** -640			
				+.015	+.296		+.182	+.140	-.037
	Yellowing	+.291	+.314	+.015	+.494	+.076	+.130	-.177	-.175
17	Orange Spotting								
		+.135	-.254	* -.463	+.262	-.062	-.078	-.153	+.263
	Yellowing	* +.418		** -.561	+.350	*** +.709	* -.451	** -.523	+.080

* = Significance P.05 = .397 in all cases.
 ** = Significance P.01 = .507 in all cases.
 *** = Significance P.001 = .620 in all cases.

is a positive correlation between yield and K_2O in frond 3 and a negative correlation between yield and CaO . There is no significant correlation between yield and MgO or P_2O_5 in frond 3. There are no significant correlations between yield and any of the ash constituents in frond 17. These results point to the conclusion that additional potash is necessary for optimum yields on poor sandstone soils as at Serdang. A possible qualification of this correlation will be referred to later.

Trends in Leaf Composition during the Period of Analyses.

During the course of the investigation, certain trends in the variation of the percentages of different nutrients were observed. The K_2O - CaO "antagonism" has been mentioned as a reason for splitting the blocks for treatments with calcium and non-calcium fertilisers. Table IV gives the results of these analyses for the period March, 1952, to June, 1953.

The results may be summarised as follows:-

(i) *Potassium.*

In frond 3 there was a fall in percentage K_2O from March, 1952, to June, 1953. The April, 1952, application of N, P, K and Mg fertilisers apparently led to a rise in the K_2O in the September, 1952, leaf samples. However, there was a subsequent fall which the K application in October, 1952, did not check. In frond 17 there was a steady fall in percentage K_2O . These observations would suggest that transfer of K to developing fruit bunches became greater as peak yields were approached, and that the applications of potash were not large enough to counteract this. Again, the results of Treatment B (fertilisers with no calcium) suggest a K-Ca "antagonism".

(ii) *Calcium.*

There was no marked change in the percentage CaO in either frond 3 or 17 during the period under review. Lower calcium contents in frond 3 (on dry matter basis) and in frond 17 (ash basis) were recorded for Treatment B palms.

(iii) *Magnesium.*

The percentage MgO dropped during the course of the trial. Observations reveal an overall increase in "yellowing", the factor shown to be connected with magnesium deficiency. The non-calcium treatment resulted in a very significant reduction in the percentage of MgO in frond 17, a factor illustrating the synergism between calcium and magnesium.

Table IV.

Variation in Chemical Composition of Fronds 3 and 17 for Treatment A (with Calcium) and B (no Calcium) for the period March, 1952, to June, 1953.

(Each figure is a mean of five sub-plots of five families = 25 samples)
(On ash basis)

Nutrient	Frond No.	Treatment	March, 1952	June, 1952	Sept. 1952	Dec. 1952	March, 1953	June, 1953	Mean Sept., 1952 to June, 1953	Effect (B - A)
K ₂ O	3	A	31.56	29.98	32.47	30.27	29.49	29.53	30.44	* +60
		B	30.97	30.26	32.57	31.79	30.15	29.64	31.04	
	17	A	—	—	14.91	14.32	14.04	13.06	14.08	-23
		B	—	—	14.41	14.19	13.61	13.17	13.85	
CaO	3	A	14.23	13.88	14.02	14.48	13.62	14.14	14.10	-21
		B	14.12	13.69	13.87	14.00	13.10	14.63	13.89	
	17	A	—	—	12.23	10.94	10.82	11.76	11.44	* -36
		B	—	—	11.30	10.92	10.68	11.43	11.08	
MgO	3	A	6.38	5.95	6.10	6.19	5.99	5.95	6.06	-04
		B	6.37	6.07	6.16	6.00	5.88	6.04	6.02	
	17	A	—	—	2.75	2.56	2.39	2.46	2.54	** -24
		B	—	—	2.60	2.25	2.03	2.31	2.30	
P ₂ O ₅	3	A	8.85	8.47	8.26	7.92	7.33	6.75	7.56	** +21
		B	8.77	8.42	8.49	8.11	7.50	6.96	7.77	
	17	A	—	—	4.23	3.83	3.69	3.71	3.87	+02
		B	—	—	4.11	3.82	3.78	3.83	3.89	
K ₂ O/ MgO (from meaned data)	3	A	4.95	5.04	5.32	4.89	4.92	4.96	5.02	+14
		B	4.86	4.98	5.29	5.30	5.13	4.91	5.16	
	17	A	—	—	5.42	5.59	5.87	5.31	5.55	+51
		B	—	—	5.54	6.31	6.70	5.70	6.06	
CaO/ MgO (from meaned data)	3	A	2.23	2.33	2.30	2.34	2.27	2.38	2.32	-01
		B	2.22	2.25	2.25	2.33	2.23	2.42	2.31	
	17	A	—	—	4.45	4.27	4.53	4.73	4.51	+34
		B	—	—	4.85	4.85	5.26	4.95	4.85	

Not analysed statistically

* = Significance P.05.

** = Significance P.01.

(iv) *Phosphorus.*

There has been a most marked and regular fall in the P_2O_5 values in frond 3 from March, 1952, to June, 1953, which would suggest that phosphate dressings have been insufficient. Even if yields had not, up to that time, been limited by deficiency, they could be later on. One interesting result was that the application of phosphorus in non-calcium form (Treatment B) gave a greater uptake of P_2O_5 in frond 3, which suggests that the palm found it easier to take up the phosphorus of ammonium phosphate in Treatment B than of rock phosphate in Treatment A.

(v) *K₂O/MgO Ratios.*

Treatment B gave a marked increase in this ratio in frond 17. The CaO/MgO ratio was also increased.

Influence of Calcium Fertilisers.

Table IV also shows the influence of Treatments A and B on nutrient uptake by the palms. The effects may be summarised as follows:-

Treatment B.

- (i) Increases the K_2O ($P = .05$) and the P_2O_5 ($P = .01$) in frond 3.
- (ii) Decreases the CaO ($P = .05$) and MgO ($P = .01$) in frond 17.

Table V shows the effect of the calcium on "orange spotting" and "yellowing".

Table V.

Influence of Treatments A and B on the
"Orange Spotting" and "Yellowing" Score.
(Recorded June, 1953, 14 months after first treatment)

Family	"Orange Spotting" Score (6 observers, 5 blocks, scale 0-9. Max. Score 270)			"Yellowing" Score (6 observers, 5 blocks, scale 0-9. Max. Score 270)		
	Treat. A	Treat. B	Mean	Treat. A	Treat. B	Mean
E.268	85.4	87.4	86.4	113.8	115.6	114.7
E.216	96.0	103.8	99.9	116.0	131.8	123.9
E.207	180.4	168.0	174.2	95.4	109.4	102.4
E.152	132.8	110.0	121.4	144.6	142.8	143.7
E.97	169.0	153.4	161.2	150.8	158.2	154.5
Mean	132.7	124.5		124.1	131.6	
A - B	8.2			-7.5		

M.S.D. at 5 per cent 16.1.
A > B (only significant at
 $P = .2$).

M.S.D. at 5 per cent 16.1.
A < B (only significant at
 $P = .2$).

There is a small, non-significant decrease in "orange spotting" with Treatment B in the three severely affected families. Treatment B showed a small increase in "yellowing" which was also non-significant.

Variation in Chemical Composition of Different Families.

In the introduction, it was noted that some of the progenies were much more susceptible to frond discolouration than others and that this observation led to the start of the examination. A brief summary is given of the differences in chemical composition of the different families, and the results are given in Table VI, which is, in effect, Table IV re-arranged to show the results by families.

The results may be summarised as follows:-

(i) *Potassium.*

Families E.268 and E.216, the higher yielding and less "orange spotted" palms, have significantly more K_2O than E.97, E.152 and E.207 in frond 3. On the other hand, E.268, with the highest K_2O in frond 3, had the lowest in frond 17, a fact bringing into significance the question of a potassium gradient within the palm. Treatment B has increased the K_2O in frond 3 in all families except E.207. The "families x treatment" interaction is significant at the 5 per cent point.

(ii) *Calcium.*

The amount of CaO in frond 3 is not significantly influenced by the different manurial treatments; in E.268 and E.216, Treatment B has a higher percentage CaO than Treatment A. The order of percentages of CaO in the ash (frond 17) is as follows:- E.207, E.268, E.216, E.152 and E.97.

The highly significant differences indicate the wide variation in physiological characters between families.

(iii) *Magnesium.*

There is little difference in percentage MgO in ash of frond 3, but treatment B (no calcium) has decreased MgO in families E.268, E.216, E.152, while showing an increase in E.207 and E.97. In frond 17, families E.268, E.207 and E.152 have a higher percentage of MgO than E.152 and E.97. Treatment B (no calcium) has decreased the MgO in frond 17 in all families, though the decrease is greater in the three families E.268, E.216 and E.152 than in E.97 and E.207.

(iv) *Phosphorus.*

In frond 3, E.207 has significantly more P_2O_5 than E.268 or E.97, and in frond 17 more than any other family. Treatment B has increased the percentage of P_2O_5 in frond 3 in all families except

Table VI.

Chemical Composition of Fronds 3 and 17 for Treatments

A (+ Ca) and B (- Ca) in Five Different Families.

(The data for the period September, 1952, to June, 1953, have been meaned and each figure is based on samples—five sub-plots at four sampling dates)

(On ash basis)

Nutrient	Frond No.	Treatment	Family Nos.					M.S.D. 5 per cent Between Families	Mean	Effect (B - A)
			E.268	E.216	E.207	E.152	E.97			
K ₂ O	3	A	32.97	31.86	29.39	28.16	29.81	.71	30.44	* +.60 (a)
		B	33.18	32.66	28.90	30.49	29.95		31.04	
		Mean	33.07	32.26	29.15	29.33	29.88			
	17	A	12.41	15.16	15.38	12.86	14.60	.51	14.08	-23
		B	13.57	15.08	12.76	13.36	14.45		13.85	
		Mean	12.99	15.12	14.07	13.11	14.53			
CaO	3	A	12.88	13.55	15.10	14.28	14.50	—	14.10	-21
		B	12.92	14.29	14.32	13.59	14.33		13.89	
		Mean	12.90	13.92	14.71	13.93	14.42			
	17	A	12.55	10.52	13.36	10.77	9.99	.48	11.44	* -36
		B	12.01	10.80	12.53	10.08	9.98		11.08	
		Mean	12.28	10.66	12.94	10.42	9.99			
MgO	3	A	5.85	6.15	6.09	6.41	5.78	—	6.06	-04
		B	5.72	5.90	6.36	6.28	5.84		6.02	
		Mean	5.78	6.03	6.23	6.35	5.81			
	17	A	2.93	2.83	2.72	2.38	1.83	.23	2.54	** -24
		B	2.49	2.42	2.67	2.12	1.81		2.30	
		Mean	2.71	2.62	2.70	2.25	1.82			
P ₂ O ₅	3	A	7.50	7.36	8.03	7.55	7.37	.43	7.56	** +.21 (b)
		B	7.51	8.18	7.99	7.70	7.44		7.77	
		Mean	7.50	7.77	8.01	7.63	7.41			
	17	A	3.79	3.66	4.54	3.74	3.60	.18	3.87	+.02
		B	4.07	3.75	4.23	3.66	3.74		3.89	
		Mean	3.93	3.70	4.39	3.70	3.67			

(a) Interaction Significant P .05.

(b) Interaction Significant P .01.

* = Significance at P .05.

** = Significance at P .01.

E.207, with the result that the "families x treatment" interaction is significant at the 1 per cent point.

One family, E.207, has responded differently from the others to treatment with fertilisers without calcium in that the percentage K_2O has decreased and so has the percentage P_2O_5 . E.207 is also the most "orange spotted" but least "yellowed" family. Frond analyses taken over a longer period might elucidate this problem, but at the moment there appears no adequate reason why this family should behave in a different fashion. These results show that the potassium-calcium "antagonism" is not a single phenomenon.

Combining Tables V and VI, a correlation coefficient of -0.875 between "yellowing" and MgO content of frond 17 achieves significance at $P = .001$. Correlation of "orange spotting" with the K_2O content of frond 3 gives a coefficient of -0.818 significant at $P = .01$, and the CaO content $+0.876$ is significant at $P = .001$.

Using Prevot and Ollagnier's suggestions (8) in respect of the percentage mineral contents of frond 3, the ratio $CaO / (K_2O + CaO + MgO)$ is correlated with "orange spotting" ($.920$) and is highly significant ($P = .001$). The K_2O of frond 3 similarly expressed and correlated gives a coefficient of -0.855 , also significant.

Nutrient Gradients Within Healthy, "Yellowed" and "Orange Spotted" Palms.

It will be noted from a study of the foregoing data that while low frond magnesium and "yellowing" are closely connected, there is no simple relationship between frond potassium and "orange spotting". The indications are that potassium in frond 3 is related to "orange spotting", but that it is not by any means a straightforward relationship.

It was considered that there might be some relationship between potassium gradient in the palm and the degree of "orange spotting". Consequently three palms were chosen in each of the five families: one palm was healthy, one "orange spotted" and one "yellowed". Leaf samples from fronds 3, 5, 9, 13, 17, 21 and 25 were taken from each of the palms for chemical analyses.

The same reliance cannot be placed on these results as on the ones previously given because time did not permit the sampling to be repeated and, also, only one palm in each case was sampled. With these reservations in mind, the results are given in tables VII, VIII and IX.

Table VII shows that the palm in family E.207, and also that in E.97, has a higher potassium value for the "orange spotted" than the healthy palms—quite contrary to what was expected. To confirm the importance of this, analyses would need to be carried out over a period of two or three years.

Table VII.

The Potassium Status of Healthy (H) and "Orange Spotted" (O.S) Palms of the Five Different Families.

(Results based on one healthy and one "orange spotted" palm in each family and expressed as percentage K_2O in ash.)

Frond No.	State of Health	Family					Mean
		E.268	E.216	E.207	E.152	E.97	
3	H	33.35	33.31	22.45	24.82	21.12	27.01
	O.S.	32.22	31.13	31.21	17.71	23.99	27.25
5	H	26.98	30.68	21.51	24.78	21.16	25.02
	O.S.	26.57	28.47	28.84	17.31	24.52	25.14
9	H	20.79	25.20	20.48	13.84	17.52	19.57
	O.S.	23.40	23.51	24.17	12.90	22.83	21.36
13	H	17.00	22.41	16.98	9.59	13.65	15.92
	O.S.	16.31	22.38	19.97	9.20	20.70	17.71
17	H	16.93	20.79	13.69	7.94	9.58	13.78
	O.S.	16.37	22.05	14.71	8.78	20.21	16.42
21	H	13.94	17.98	10.31	9.13	10.26	12.42
	O.S.	9.63	16.29	18.51	8.60	19.95	14.59
25	H	10.93	14.45	11.16	5.50	10.07	10.42
	O.S.	8.91	16.61	13.46	4.81	14.51	11.66

but it does show that the "orange spotting"-potassium relationship is complicated.

Work in Africa (5) has suggested that manganese deficiency may also be associated with "orange spotting", and so manganese was determined in these palms. The results are given in Table VIII.

Table VIII.

The Manganese Status of Different Fronds of Healthy, "Yellowed" and "Orange Spotted" Palms based on Meaned Data from Five Palms Analysed.

(Expressed as percentage Mn in ash)

Frond No.	Healthy	"Yellowed"	"Orange Spotted"
3	0.379	0.306	0.378
5	0.491	0.316	0.341
9	0.561	0.372	0.401
13	0.651	0.357	0.349
17	0.689	0.307	0.303
21	0.679	0.364	0.386
25	0.545	0.327	0.301

These results show quite wide differences in the older fronds of healthy and unhealthy palms. Furthermore it was noted that the two healthy palms in families E.207 and E.97 had exceptionally high values for manganese. In E.207, frond 17 in the healthy palm had 1.12 per cent Mn as against 0.43 per cent in the "orange spotted" palms. In E.97, the healthy palms had 1.25 per cent as against 0.20 per cent in the "orange spotted" one. Too much significance should not be attached to these results, but they indicate further lines of investigation.

Table IX gives the results for magnesium. This further confirms that magnesium deficiency and "yellowing" are closely inter-related. Though the genetic differences are quite marked, there is a clear distinction between the magnesium content of healthy and "yellowed" leaves in each family and in every frond. Some of these results are shown in Graph I.

Table IX.

The Magnesium Status of Healthy (H) and "Yellowed"
(Y) Palms of the Five Different Families.

(Results based on one healthy and one "yellowed" palm
in each family and expressed as percentage MgO in ash)

Frond No.	State of Health	Family					Mean
		E.268	E.216	E.207	E.152	E.97	
3	H	6.04	6.07	7.63	5.33	6.97	6.41
	Y	5.03	4.51	5.73	4.61	3.81	4.74
5	H	5.93	5.94	6.99	4.37	6.21	5.89
	Y	5.59	3.44	4.57	2.74	3.28	3.92
9	H	4.30	4.78	6.28	3.70	5.01	4.81
	Y	4.06	2.18	4.24	1.18	2.91	2.91
13	H	4.43	4.32	5.07	2.37	4.62	4.16
	Y	3.12	1.57	3.16	1.33	1.84	2.20
17	H	2.98	3.83	4.03	1.72	3.57	3.23
	Y	2.15	1.44	3.09	1.03	1.10	1.76
21	H	3.14	3.21	5.03	1.62	3.99	3.40
	Y	1.93	1.47	2.53	0.77	1.26	1.60
25	H	2.47	3.07	3.70	1.12	3.05	2.68
	Y	1.30	1.59	1.60	0.59	1.12	1.24

It is clear from Table IX that the "yellowed" palms in all the families have a lower MgO in every frond.

These results show that further investigation of nutrient gradients within the palm would be of much interest. The oil palm bunch is rich in potassium (3) and the steady fall in the percentage K_2O in the frond with increasing age shows that the maturing bunch draws nutrients from the older fronds. In addition to the translocation of nutrients from the older fronds to the developing fruit bunches, there may be some transfer from the older to the younger fronds since it has been noted that palms heavily pruned of their fronds are more spotted than unpruned palms.

Comparison of Malayan and African Data.

Prevot and Ollagnier (8) proposed critical levels for various nutrients in the oil palm in Africa. Their data is expressed as a percentage of the element on a dry matter basis and the necessary conversions have been made so that their values can be compared with those from Malaya.

Table X.

Proposed Critical Levels of Prevot and Ollagnier
Compared with Serdang Figures for Frond 17.
(Expressed as percentage on dry matter basis)

Nutrient	Prevot and Ollagnier	Serdang
N	2.75	2.08
P_2O_5	.34	.30
K_2O	1.38	1.11
CaO	.84	.86
MgO	.40	.19
K_2O/P_2O_5	4.06	3.63

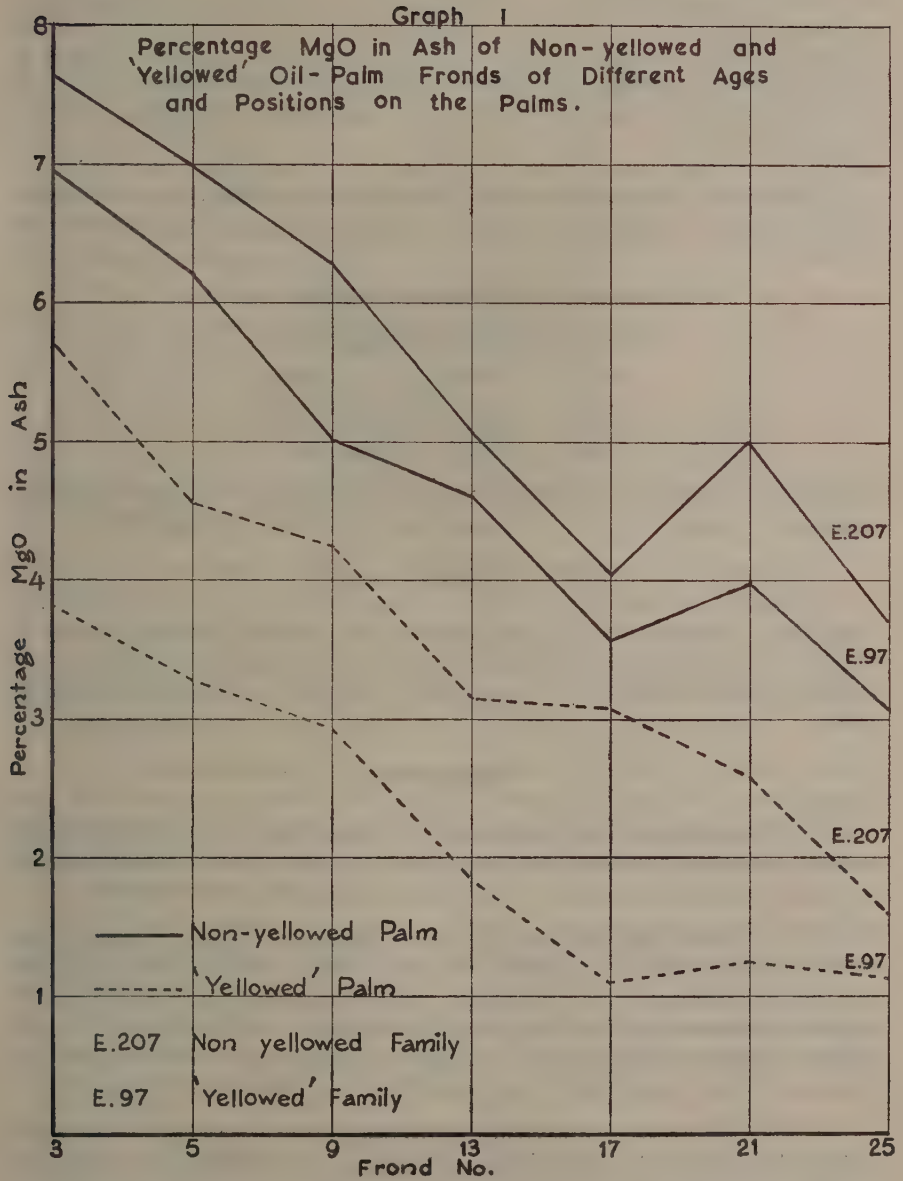
Chapman and Gray (4) predicted manurial responses if the following conditions were satisfied:-

Response to K if the ratio K_2O/P_2O_5 is less than 2.5.

Response to K + P if the ratio K_2O/P_2O_5 is between 2.5 and 3.5.

Response to P if the ratio K_2O/P_2O_5 is greater than 3.5.

In comparison with Prevot's "critical" levels, Serdang palms are deficient in N, P_2O_5 , K_2O and MgO and have excess CaO.



Compared with Prevot's value for MgO of 0.40 per cent, the Serdang mean of 0.19 per cent appears remarkably low. Even healthy palms at Serdang do not exceed 0.25 per cent. It should be noted, however, that Prevot proposes a value of 2.6 per cent from the sum of $K_2O + MgO + CaO$, whereas the Serdang mean is only 2.16 per cent. Raising the value of the K_2O in the Serdang palms to the critical level suggested by Prevot might also mean that the MgO would have to be raised to maintain the optimum nutrient balance.

Broeshart (1), working in the Belgian Congo, has drawn up triangular diagrams for leaf composition and puts forward the optimum composition as follows:-

(Expressed as percentage of ash for frond 3)

K_2O	30.1 to 31.3 per cent
CaO	9.8 to 12.6 per cent
MgO	6.2 to 8.0 per cent
P_2O_5	4.9 to 5.7 per cent

Compared to Serdang palms, these figures show a similar value for potassium, considerably lower calcium and phosphorus, and higher magnesium.

In contrast to Chapman and Gray's suggestion that there will be no potash response when the K_2O/P_2O_5 ratio exceeds 3.5, it can be calculated from Prevot's figures that for conditions to be optimum the ratio should be about 4.06. As our data show an R value of 3.6, yet there is a strong suggestion of potash deficiency, we suggest that Prevot's value of 4.06 is the better.

Discussion.

All the analyses were carried out on palms situated in one field at the Federal Experiment Station, Serdang, and are thus subject to the advantages and disadvantages of samples taken under only one set of conditions.

The palms were all growing on the same soil type, a sandy loam derived from weathered quartzite, were of known genetic history and had had uniform treatment from planting. The disadvantage is that the results would not necessarily hold for palms grown on a different type of soil, though, as we are dealing with the result of unbalanced nutrition, the consequences of such are likely to be similar even on differing soil types.

The results of the investigation show that leaf analysis is a useful method for examining physiological disorders of oil palms, but they also point to the fact that the ratio in which the nutrients occur is as important, if not more important than the absolute quantities occurring in the leaves. The problem of whether the results should be expressed on ash or dry matter content is an important one and needs much further work to elucidate it. Convincing enough argument can be put up for expression on either basis,

but obviously, if different conclusions can be drawn, dependent on the method of expression, the problem needs investigation. It cannot be properly solved until leaf analysis is combined with a series of manurial trials.

Practically all the work, both in Malaya and Africa, emphasises the need for balanced manuring of oil palms, which appear to be particularly sensitive to nutrient ill-balance. The types of upland soils on which oil palms are often grown, i.e. the sandy and sandy clay soils derived from quartzites and shales, are low in bases and have a lower base exchange capacity, so that ill-balanced manuring more readily upsets the nutrition of plants. On peats also, the balance is easily disturbed, but the heavier coastal clays are not so sensitive.

Thus when considering the manuring of oil palms, to the question "how much, and how often?" must be added the question, "in what ratios and in what form?"

One further point is the question of the calcium supplied in rock phosphate. Our results show that calcium can depress the uptake of potassium, but this is only likely to have ill effects where the potassium supply is marginal. If the potassium is in adequate supply, it is unlikely that the calcium would have ill effects.

Summary.

It has been shown that the physiological disorder known as "bronzing" can be divided into two types, "orange spotting" and "yellowing". Degree of "yellowing" can be correlated with magnesium content of the frond, while "orange spotting" is connected with a deficiency of potassium.

A system of scoring for the degree of "orange spotting" and "yellowing" on palms at the Federal Experiment Station, Serdang, has been initiated and correlation of the scores with yield, and with chemical composition of fronds 3 and 17 worked out. A high degree of "orange spotting" is associated with a decrease in yield.

A high calcium content in the fronds is also associated with "orange spotting", and attempts were made to lower this by manuring with non-calcic fertilisers.

The variation in chemical composition of fronds from five different families and the decrease in nutrient with increasing age of the frond are recorded.

Acknowledgements.

Our thanks are due to Mr. S. Thamboo, of the Soils Chemistry Division, who was responsible for all the sampling and chemical analyses recorded in this paper; to the staff of the Federal Experiment Station, Serdang, for maintaining the field and yield records; and to the students at the College of Agriculture for doing the frond discolouration scoring.

We also wish to place on record that Dr. T. A. Buckley, former Senior Chemist, was responsible for initiating work on oil palm leaf analyses. Finally, we would like to acknowledge the helpful interest taken in this investigation by Mr. R. B. Jagoe, Chief Research Officer.

References.

- (1) Broeshart, H. (1954): "The Use of Foliar Analyses in Oil Palm Cultivation"—*Trop. Agric.*, **31**, 251.
- (2) Bull, R.A. (1954): "Studies on the Deficiency Diseases of the Oil Palm"—*J. WAIFOR.*, **2**, 94.
- (3) Bunting, B., Georgi, C.D.V. and Milsum, N. (1934): "The Oil Palm in Malaya"—Dept. of Agric., Malaya, 98.
- (4) Chapman, G.W. and Gray, H.M. (1949): "Leaf Analysis and the Nutrition of the Oil Palm"—*Ann. Bot.* **13**, 415.
- (5) Elgabaly, M.M. (1952): "Nutrient Balance and Interaction Effects on Soil Fertility"—1952, *Trans. Int. Soc. Soil Sci.* Commissions II and IV, **1**, 195.
- (6) Ferrand, M., Bachy, A., and Ollagnier, M. (1951): "Les Oligoelements dans la Fumure du Palmier a Huile au Moyen Congo"—*Oleagineux*, **6**, 629.
- (7) Hale, J.B. (1947): "Mineral Composition of Leaflets in Relation to the Chlorosis and Bronzing of Oil Palm in West Africa"—*J. Agric. Sci.*, **37**, 236.
- (8) Prevot, P. and Ollagnier, M. (1953): "Engrais minéraux et Oleagineux Tropicaux—Recherches d'Agrophysiologie"—*Oleagineux*, **8**, 848.
- (9) Prevot, P. and Ollagnier, M. (1954): "Peanut and Oil Palm Foliar Diagnosis. Inter-relations of N, P, K, Ca, Mg."—*Plant Physiol.*, **29**, 26.
- (10) Schedecker, D. and Prevot, P. (1954): "Nutrition Minerale du Palmier a Huile a Pobe"—*Oleagineux*, **9**, 13.
- (11) Thomas, W. (1945): "Present Status of Diagnosis of Mineral Requirements of Plants by Means of Latex Analyses"—*Soil Sci.*, **59**, 353.
- (12) WAIFOR. (1953): Quarterly Progress Report No.4, West African Inst. for Oil Palm Research, p.14-17.

FURTHER INVESTIGATIONS INTO THE USE OF SELF-PROPELLED COMBINE HARVESTERS FOR THE HARVESTING OF WET PADI IN THE NORTH KEDAH PLAIN

BY

D. W. M. HAYNES,
Agricultural Engineer I.

Introduction.

The circumstances which led to the purchase of a large self-propelled combine harvester (Massey-Harris No. 80 S.P. Rice Special Combine) and to the trials in Kedah during the 1953-54 season have been described (2). In the present paper, in which further trials in Kedah during the 1954-55 season are described, the methods of calculating costs, etc. used in the earlier report have again been adopted and an attempt has been made to explain differences between the results of the two seasons' trials.

Field Tests of the No. 80 S.P. Rice Special Combine in Kedah, 1954-55 Season.

The trials were conducted, as in the 1953-54 season, by mechanics and operators from the Workshop and Pool, Serdang, Selangor, under the supervision of an Agricultural Development Officer or an Agricultural Engineer. A total of 19.1 acres, yielding 23.2 tons (9,270 *gantang*) of padi, was harvested. The combine worked 52.7 hr. in 12 days out of a possible 34 days: work was prevented by rain on two days, by public holidays on three days, by lack of suitable crops on three days and by breakdowns on 14 days.

Modifications.

The performance of the standard grain dividers fitted to the Massey-Harris No. 80 combine was not entirely satisfactory during the 1953-54 trials and it was decided that a vertical knife divider and a long grain divider should be obtained, but funds for the purchase of these accessories did not become available until November, 1954, and they could not be delivered in time for trials during the 1954-55 harvest. A simple, conical divider was therefore fabricated from sheet metal and mounted on an adjustable bracket welded to the crop side of the cutting table: this divider, which was 46 in. long and 9 in. broad at the top, enclosed the protruding end of the knife and was fitted with a long, inclined bar to lift any tillers which were pushed down.

The deep ruts left by the rear wheels of the combine in wet soil conditions caused some concern during the 1953-54 trials. An attempt was made to reduce the depth of these ruts by fitting extension rims to the rear wheels. The radius of these rims was 4 in. less than that of the tyres and they did not touch the ground under normal conditions. The bracket holding the sack chute had to be modified slightly to provide adequate clearance for the extension rims.

A number of methods of providing remote control for the reel height adjustment were considered, but none of the proposals appeared to be completely satisfactory and neither staff nor funds were available for experimental modifications.

The Influence of Weather Conditions.

The weather conditions prevailing during the 1954-55 season differed markedly from those experienced during the previous one. During late December, 1953, and January, 1954, the air was humid and hot and dense cumulus clouds formed during the afternoons, but, except for brief squalls before rain, winds were very light; rain showers occurred about every three days and heavy dew formed each night. During the 1954-55 season, however, the air was dry and felt relatively cool; the sky was normally cloudless but a steady wind blew continuously from the north-east. Only two rain showers fell in 34 days, and the dew was very light. The diurnal changes in the moisture content of the padi were far less marked and the crops harvested had a lower moisture content than in the previous season; unfortunately, however, lack of staff prevented shift work to take advantage of the longer working hours which were made possible by the slower rise of the moisture content in the grain during the evening.

The Influence of Soil Conditions.

During the first week of the 1954-55 harvest season, the soil was generally moist, and a few low-lying fields were wet and soft. The soil soon dried out, however, and soil conditions towards the end of the trials were extremely good. The combine was used in only one wet plot and the extension rims for the rear wheels were given only a short trial. They appeared to be unsatisfactory in that they made steering extremely difficult, and they became choked with mud and straw and did not revolve freely in wet soil.

The Influence of Crop Conditions.

The padi crop ripened quickly and the harvest season was shorter than in 1953-54. On the 15th January, 1954, for example, there was a considerable acreage of padi to be harvested in the area around Simpang Empat and Tokai villages, but on the same day in 1955 only a few, low-lying plots remained uncut. There was no general shortage of casual labour during the harvest and much harvesting was carried out at night by the light of the full moon.

As a result of the drying effect of the wind, the grain and leaves ripened and dried more rapidly than the padi stems: green stems caused considerable difficulty (see Table I) by winding round the drum and causing blockages. It is possible that a peg-tooth drum and concave, such as are fitted to the Massey-Harris No. 90 Rice Combines (3) used in North Italy (4), would have dealt more effectively with this green straw than the rasp-bar drum and wire concave fitted to the combine used in these trials. A peg-tooth drum might, however, have increased the blockages and breakages

which occurred through the overloading of the tailings return system with short lengths of green stem which were too heavy to be blown away with the chaff.

Table I.

Working Time Lost Through All Causes Except Rain and
Major Mechanical Failures.

Site	Acreage	Time taken	Time lost	Time lost	Remarks
		min.	min.	per cent	
I	0.66	50	Nil	—	
II	0.75	180	40	22.2	20 min. lost by bogging 20 min. by blockages caused by under-ripe straw.
III	2.75	270	60	22.2	Blockages caused by under-ripe straw.
IV	1.50	134	Nil	—	
V	6.14	1588	390*	24.6*	Blockages caused by wet straw.
VI	0.71	150	10	6.7	Blockages caused by damp straw
VII	1.42	205	Nil*	—*	
VIII	2.85	335	10	3.0	
IX	0.53	92	15	16.3	Blockages caused by green straw.
X	1.10	131	Nil	—	

* Does not include delays due to major mechanical failures. See text.

The strong wind caused considerable lodging of the crop, especially on fertile land, but the conditions were no worse in this respect than in the previous season, when large areas of padi were laid flat by rain squalls. On one plot (Site reference V in Tables II and III), where harvesting was delayed for 10 days by breakdowns, the crop was lodged very badly and lay in a tangled mat about 12 in. thick on the ground. Although, in the opinion of experienced labourers, this crop could not have been harvested with a sickle, it was gathered successfully, albeit slowly, by the combine. The modified divider, which was extremely satisfactory in standing crops, was not suitable for use in laid crops since it lifted a strip of the crop too high and caused blockages of the pick-up reel.

The average yield of all trial sites was 2,269 lb. per acre as compared with 2,458 lb. per acre during the 1953-54 season. This reduction does not necessarily imply a general reduction in the average yield of the North Kedah

Plain as a whole, since it was necessary to seek sites in the less fertile districts on the edge of the padi area at the end of the season.

Mechanical Failures and Breakdowns.

A total of 14 days was lost through major breakdowns. The main failures were:-

(i) *Front Elevator Shaft.*

This shaft, which drives the front elevator, the cutting table mechanisms and the reel, fractured at the shoulder where the diameter was reduced. No spares were available in Malaya or neighbouring territories and 11 days were lost before a new shaft could be made and fitted. It was noted that this particular type of shaft was used in machines manufactured in 1952 only and that a modified part is recommended for use when making repairs.

(ii) *Pick-Up-Reel Hub Clamp Cap.*

This clamp, which attaches the reel driving-pulley to the reel spindle, broke while the combine was working in the very badly lodged crop referred to above. No spares were available in Malaya and two days were lost in casting and fitting a bronze replacement.

(iii) *Hydraulic Pump Cover Seal.*

Oil leaks from the hydraulic pump became progressively worse as the work progressed, and the rubber seal was eventually replaced with a paper washer. It was apparent that the original seal had been twisted during assembly.

(iv) *Tailing Elevator Chain.*

One of the attachment links for the canvas flights of the elevator chain broke when the combine was working in an under-ripe crop. Since no spares were available in Malaya, the broken attachment was replaced by a plain link and the canvas flights rearranged to maintain an equal spacing.

In addition to delays due to these major failures, time was lost through minor failures and adjustments, through blockages of the drum and elevators and, on one occasion only, through bogging. The time lost due to these causes is shown in Table I. The average lost time was 9.5 per cent, as compared with 9.2 per cent during the previous season, but if the 14 days lost through major failures are taken into consideration the overall lost time was 73.8 per cent of the total available time. The time spent in removing broken parts and refitting new components accounted for only a few hours; if spare parts had been readily available the overall lost time would have been only 10-12 per cent.

The experience gained during the 1954-55 season emphasises the necessity of holding large stocks of spares (preferably in the form of complete replacement units which can be fitted quickly under field conditions) for

Table II.
Working Rates.

Site	Crop				Soil	Working Rate		Remarks
	Area in acres	Variety or type of padi	Yield in lb. per acre	Condition		Machine hr. per acre	Man-machine hr. per acre	
I	0.66	Radin Goya	2,417	Ripe, dry grain, green straw: lodged in one direction.	Moist but firm	1.27	2.54	
II	0.75	Subang Intan	3,093	Ripe grain, green straw: lodged.	Wet and very soft	4.00	8.00	Bogging occurred.
III	2.75	Radin China	2,768	Ripe grain, green straw: standing well.	Moist but firm	1.27	2.54	
IV	1.50	Siam 29	1,933	Ripe grain, ripe straw: slightly lodged in one direction.	Hard	1.49	2.98	
V	6.14	Subang Intan	3,401	Over-ripe grain, wet straw: very badly lodged and tangled.	Firm	4.35	8.70	Straw lying in 6 in. blanket on surface. Three major breakdowns occurred.
VI	0.71	Radin type	1,864	Ripe, damp, grain and straw: lodged and tangled.	Hard	3.57	7.14	
VII	1.42	Radin type	2,247	Ripe grain, green straw: slightly lodged in one direction.	Hard	2.40	4.80	Elevator chain broke.
VIII	2.85	Radin type	1,781	Ripe, damp grain and straw: slightly lodged.	Hard	1.96	3.92	
IX	0.53	Radin type	2,462	Unripe, damp grain, green straw: standing well.	Hard	2.39	5.78	Triangular plot.
X	1.10	Radin type	725	Unripe, damp grain, green straw: slightly lodged.	Hard	1.98	3.96	

Table III.
Output.

Site		Crop			Soil condition	Output	
Reference	Area in acres	Variety or type of padi	Yield in lb. per acre	Condition		lb. per machine-hr.	Gantang per machine-hr.
I	0.66	Radin Goya	2,417	Ripe, dry grain, green straw: lodged in one direction.	Moist but firm	1,914	341.8
II	0.75	Subang Intan	3,093	Ripe grain, green straw: lodged.	Wet and very soft	773	138.0
III	2.75	Radin China	2,768	Ripe grain, green straw: standing well.	Moist but firm	2,176	388.6
IV	1.50	Siam 29	1,933	Ripe grain, ripe straw: slightly lodged in one direction.	Hard	1,299	232.0
V	6.14	Subang Intan	3,401	Over-ripe grain, wet straw: very badly lodged and tangled.	Firm	789	140.9
VI	0.71	Radin type	1,864	Ripe, damp grain and straw: lodged and tangled.	Hard	522	93.2
VII	1.42	Radin type	2,247	Ripe grain, green straw: slightly lodged in one direction.	Hard	934	166.8
VIII	2.85	Radin type	1,781	Ripe, damp grain and straw: slightly lodged.	Hard	909	162.3
IX	0.53	Radin type	2,462	Unripe, damp grain, green straw: standing well.	Hard	851	152.0
X	1.10	Radin type	725	Unripe, damp grain, green straw: slightly lodged.	Hard	332	59.3

Table IV.

Working Rate and Output.

Conditions for combining	Site reference	Crop and soil conditions	Machine-hr. per acre	Lb. per machine-hr.
Average	III	Ripe grain, green straw, standing well: soil firm	1.27	2,176
	IV	Ripe grain, ripe straw, slightly lodged in one direction: soil hard	1.49	1,299
	VII	Ripe grain, green straw, slightly lodged in one direction: soil hard	2.40	934
	I	Ripe grain, green straw, lodged in one direction: soil firm	1.27	1,914
Average in average conditions			1.61	1,581
Bad	VIII	Ripe, damp grain and straw, slightly lodged: soil hard	1.96	909
	IX	Unripe, damp grain and straw, standing well: soil hard	2.89	851
	X	Unripe, damp grain and straw, slightly lodged: soil hard	1.98	332
	II	Ripe grain, green straw, lodged: soil wet and very soft	4.00	773
	VI	Ripe, damp grain and straw, lodged and tangled: soil hard	3.57	522
	V	Over-ripe grain, wet straw, very badly lodged and tangled: soil firm	4.35	789
Average in bad conditions			3.13	696
Overall average			2.52	1,050

machines such as combines, which have a strictly limited working season. It will be uneconomic to hold adequate spares for a single machine, and combines will have to be used in groups of five to ten machines if the investment in spares is to be kept in due proportion to working capacity.

Working Rates and Outputs of the Combine.

The working rates of the Massey-Harris No. 80 S.P. Rice Special Combine, in machine-hours and man-hours per acre, are given in Table II, and the outputs, in *gantang* and lb. per machine hour, in Table III. Details of the sites, arranged in chronological order, are given in these tables.

Tables II and III have been combined in Table IV with the sites arranged in accordance with the crop and soil conditions to show how these factors affect the working rate and output. It will be noted that no 'Good Conditions' are shown in Table IV, as each of the sites used during the present season had a disadvantage, such as under-ripe straw or lodging.

It will be seen from the tables that the average working rate on all sites was 2.52 machine hours per acre, equivalent to 0.40 acres per hour, as compared with 1.80 machine hours per acre, equivalent to 0.56 acres per hour, during the previous season. This reduction in working rate was due to the slower forward speeds necessary in the more difficult conditions encountered and not, as can be seen from Table I, to an increase in lost time due to blockages, bogging or minor breakdowns.

The average working rates in different conditions during the 1953-54 and 1954-55 seasons are given in Table V.

Table V.

Average Working Rates.

Conditions	1953-54 Season		1954-55 Season	
	Hr. per acre	Acres per hr.	Hr. per acre	Acres per hr.
Good	1.04	0.97	—	—
Average	1.93	0.52	1.61	0.62
Bad	2.52	0.40	3.13	0.32
Overall average	1.80	0.56	2.52	0.40

The average outputs under different conditions during the two seasons are given in Table VI.

Table VI.

Average Outputs.

Conditions	1953-54	Season	1954-55	Season
	Lb. per hr.	<i>Gantang</i> per hr.	Lb. per hr.	<i>Gantang</i> per hr.
Good	2,182	389.6	—	—
Average	1,443	257.7	1,581	282.3
Bad	1,134	202.5	696	124.3
Overall average	1,597	285.2	1,050	187.5

The Cost of Harvesting Padi with the Combine.**ESTIMATE OF USEFUL LIFE.**

It appears possible that the estimate of useful life used in calculating the cost of harvesting padi with the Massey-Harris No. 80 S.P. Rice Special Combine during the 1953-54 season (2) was slightly optimistic rather than, as was intended, conservative. While there is no reason to suppose that the estimated life of five years will not be achieved or exceeded, it is possible that the average number of working days may be less than the estimate of 34 per season since the working season may be restricted in very dry, as well as in very wet years. There is not yet, however, sufficient evidence to warrant any departure from the estimate of useful life of 2,000 hr., giving a depreciation charge of \$11.52 per hr., used in costing the 1953-54 trials (2).

REPAIR AND MAINTENANCE COSTS.

When first experimenting with a machine such as a combine, it is necessary to estimate the charge to be made for repairs since no records of actual costs are available (1). In costing the 1953-54 trials, repairs were charged at the arbitrary rate of one-half of the depreciation charge, i.e. at \$5.76 per hr. (2), and a total of \$702.72 was credited to the repair account, although the actual expenditure on repairs was less than \$100. If the balance of over \$600 remaining in this account at the end of the 1953-54 season had been spent on a thorough overhaul and piece-by-piece inspection of the combine it is possible that incipient failures would have been detected and the field breakdowns during the 1954-55 season averted.

In costing the present season's trials, therefore, the same repair charge of \$5.76 per hr. has been used in calculating costs. A further sum of \$259.20 has been credited to the repair account and, after deducting expenditure on repairs during the present season, a balance of slightly less than \$600 remains in this account. This balance will be spent on a thorough overhaul and inspection of the combine.

The maintenance charge of 81 cents per hr. used in costing the 1953-54 trials (2) has again been adopted.

TOTAL FIXED COST.

The total fixed cost, obtained by adding together depreciation, repair and maintenance costs, amounted to \$18.09 per hr.; this is the same total fixed cost as was used in costing the 1953-54 trials.

FUEL COSTS.

The fuel consumption of the combine during the 1954-55 trials was 1.72 gallons per hr., as compared with 1.74 gallons per hr. during the previous season (2). The present retail cost of petrol is \$1.47 per gallon, and a fuel charge of \$2.53 per hr. has therefore been used in calculating the cost of combining during the 1954-55 trials. The corresponding cost during the 1953-54 season was \$2.61 (2) due to the higher fuel consumption and higher fuel price.

COST OF LABOUR.

The wages of operators and labourers remained unchanged during the year, and the total labour charge of \$1.37 per hr. used in costing the trials in the previous season (2) has again been adopted.

OPERATING COST.

The total operating cost of the Massey-Harris No. 80 S.P. Rice Special Combine during the 1954-55 season is shown in Table VII.

Table VII.

Operating Cost.

	Operating cost per hour	Percentage of total cost
Depreciation	\$11.52	52
Repair	5.76	26
Maintenance	.81	3
Fuel	2.53	12
Labour	1.37	7
Total	21.99	100

The costs of combining per acre and per 1,000 *gantang* of padi are shown for each site in Table VIII, the sites being grouped according to conditions as in Table IV. The average costs in different conditions during the 1953-54 and 1954-55 seasons are shown in Table IX. The high overall

Table VIII.
Trials of Massey-Harris No. 80 S. P. Rice Special Combine 1954-55.
Operating Costs.

Conditions for combining	Site reference	Crop and soil conditions	Cost per acre \$	Cost per 1,000 <i>gantang</i> \$
Average	III	Ripe grain, green straw, standing well: soil firm	26.88	52.77
	IV	Ripe grain, ripe straw, slightly lodged in one direction: soil hard	31.55	91.31
	VII	Ripe grain, green straw, slightly lodged in one direction: soil hard	51.10	127.05
	I	Ripe grain, green straw lodged in one direction: soil firm	26.91	61.95
Average in average conditions			34.11	83.27
Bad	VIII	Ripe, damp grain and straw, slightly lodged: soil hard	41.51	130.47
	IX	Unripe, damp grain and straw, standing well: soil hard	61.20	139.32
	X	Unripe, damp grain and straw, slightly lodged: soil hard	46.74	357.11
	II	Ripe grain, green straw, lodged: soil wet and very soft	84.69	153.54
	VI	Ripe, damp grain and straw, lodged and tangled: soil hard	75.60	227.22
	V	Over-ripe grain, wet straw, very badly lodged and tangled: soil firm	92.08	150.31
Average in bad conditions			66.97	192.96
Overall average			53.83	149.09

average cost during the present season is due, mainly, to the high proportion of bad conditions.

The wages of the operator and his assistant during the delays due to mechanical failures have not been charged. If the total wages bill for the season was charged against the work done, the hourly labour cost would rise to \$8.27 and the overall average cost of combining would rise by 31.5 per cent to \$70.72 per acre or \$195.86 per 1,000 *gantang*.

Table IX.

Costs of Combining.

Conditions	1953-54 Season		1954-55 Season	
	\$ per acre	\$ per 1,000 <i>gantang</i>	\$ per acre	\$ per 1,000 <i>gantang</i>
Good	23.12	57.12	—	—
Average	42.57	89.35	34.11	83.27
Bad	55.71	135.37	66.97	192.96
Overall average	39.76	90.78	58.83	149.09

The Economics of Combine Harvesting.

The cost of contract harvesting by hand in Kedah during the present season varied considerably but appeared to average about \$30 per *relong* or \$42.19 per acre as in the previous season. The average cost of combining was \$53.83 per acre or about 27 per cent more than hand-harvesting. However, under average conditions, the cost of combining was generally less than that of hand work, and the overall average cost would undoubtedly have been lower had the combine not broken down at a time when the best crops were ripe.

Summary.

1. A modified grain divider and rear wheel extension rims for the Massey-Harris No. 80 S.P. Rice Combine are described.
2. The field trials in Kedah during the 1954-55 season are described and the influence of weather, soil and crop conditions discussed.
3. The major mechanical failures, which caused the loss of 14 working days, are described.
4. The time lost through minor faults, bogging and blockages is shown to have averaged less than 10 per cent (Table I). A similar result was obtained in the 1953-54 season.

5. Working rates and outputs under different conditions are given and it is shown that, under average conditions, the combine harvested 0.4 acres per hr., as compared with 0.5 acres per hr. during the 1953-54 season. Outputs of grain were lower, due to the lower working rates and lower yields, averaging 1,050 lb. per hr. (Tables III and IV), as compared with 1,597 lb. per hr. during the 1953-54 season.

6. The estimate of useful life used in costing the 1953-54 trials is discussed and it is concluded that, although the estimate of 2,000 hr. may be optimistic, there is insufficient new evidence on which to base a revised estimate.

7. The cost of combining averaged \$53.83 per acre as compared with \$39.76 per acre during the 1953-54 season (Table IX). It is suggested that the average cost would have been lower if the combine had not broken down at the time when the best crops were ripe.

Acknowledgements.

I am indebted to Mr. A. Cumming, Agricultural Development Officer, who conducted most of the field trials; to Messrs. Chen Foong Onn, Yacob bin Abdullah and Yong Kok Chong of the staff of the Workshop and Pool, Serdang; and to Mr. E. J. H. Berwick, State Agricultural Officer, Kedah and Perlis, and his staff who helped me in many ways.

References.

- (1) Haynes, D.W.M. (1954): "The Calculation of Costs of Mechanical Operations with Particular Reference to the Mechanised Harvesting of Rice"—*Malay. agric. J.*, **37**, 54.
- (2) Haynes, D.W.M. (1954): "The Use of Self-Propelled Combine Harvesters for the Harvesting of Wet Padi in the North Kedah Plain"—*Malay. agric. J.*, **37**, 68.
- (3) Anon. (1954): "Paddy Field in an English Park"—*Pwr. Fmr.*, **13**, 150.
- (4) Anon. (1955): "Rice Growing in Europe: Post War Developments"—*Farming Recorder*, No. 1, January, 1955, 7.

THE CULTIVATION OF FODDER GRASSES IN MALAYA

PART III. The Time and Frequency of Application of Fertilisers.

BY

R. HENDERSON,

Acting State Agricultural Officer, Kelantan.

The experiments reported in the previous articles (1 and 2) in this series have shown that large increases in yields of Guinea grass (*Panicum maximum*) can be obtained by the use of fertilisers. They have also shown, however, that the amounts of fertiliser required to achieve such yield increases are very considerable. A practical issue raised by these findings was that of the frequency with which fertilisers should be applied. On theoretical grounds, it seemed that risks of fertiliser losses by leaching and overdosing would be less if applications were made often and in small quantities than if they were made infrequently and in large amounts. An experiment which was carried out to investigate this possibility is described in the following paragraphs.

EXPERIMENT No. F.E.S.S. 67.

The object of the experiment was to test the effects on yields and growth of Guinea grass of varying the number of applications per annum of a fixed annual amount of fertiliser. The treatments included in the experiment were as follows:-

- A. Fertiliser applied in 12 dressings, one every month.
- B. Fertiliser applied in six dressings, one every two months.
- C. Fertiliser applied in three dressings, one every four months.
- D. Fertiliser applied in two dressings, one every six months.

The layout comprised five randomised blocks of four plots each. The plot dimensions were 10 x 16 ft., and each plot was surrounded by a 2 ft. wide discard strip.

The experiment was sited in the General Nursery at the Federal Experiment Station, Serdang, Selangor, in the area described in the introductory article (1) of this series. The site had been under short-term, arable crops for many years prior to establishment of Guinea grass, and the soil was in reasonably good heart. Guinea grass was planted at 2 x 2 ft. spacing in September, 1949.

The annual fertiliser application was changed in composition and quantity at the end of the first year and again at the end of the second year of the experiment. Details of the various applications are given in Table I.

Table I.

Composition of Fertiliser Application per Acre per Annum.

(cwt.)

Period	Sulphate of Ammonia	Superphosphate	Muriate of Potash
Sept., 1949, to Aug., 1950	3	3	2
Sept., 1950, to Aug., 1951	6	Nil	4
Sept., 1951, to Dec., 1953	3	1*	3

* Double superphosphate.

The first experimental applications of fertiliser were made on the 20th September, 1949; subsequent applications being made as required by the treatments until the 20th August, 1951. Experimental harvesting began in October, 1949, and was carried out at monthly intervals until September, 1951. There was some doubt about the future of the trial at that time, and experimental manuring and harvesting were temporarily suspended; however, these operations were resumed in December, 1951, and January, 1952, respectively. When operations were resumed, it was decided that the harvesting interval should be extended to $1\frac{1}{2}$ months. This, it will be realised, introduced intra- and inter-treatment variations in the length of time from manuring to succeeding harvest, a feature which the experiment did not possess in its first two years, when harvesting was at monthly intervals.

A further source of non-experimental, inter-treatment variation was introduced, in error, in the third year of the trial. This comprised increases in the total amount of fertiliser applied per treatment in the third year, with a decrease in the frequency of application. This was caused by application of the first dressing for all treatments at the second year rate (see Table I) followed by application of all subsequent dressings at the third year rate. This clearly invalidates any conclusions which might be drawn, from the yields obtained in the second and third years, about the effects of the treatments. These yields are therefore not considered in drawing such conclusions.

Yield data for the first and second years of the experiment are given in Table II, and the yields for the four years of the trial are illustrated in Graph I.

Table II.

Experiment No. F.E.S.S. 67.

Yields of Fresh Cut Grass per Acre per Annum.

(tons)

Period	Treatments				Means
	A	B	C	D	
Sept., 1949, to Sept., 1950	28.49	26.54	26.28	27.86	27.29
Sept., 1950, to Sept., 1951	26.59	25.21	25.23	25.72	25.69
Means	27.54	25.88	25.75	26.79	26.49

Significant difference between two means at :-	5 per cent	1 per cent
Treatment means:	2.792	3.914
For testing years times treatments interactions:	1.612	2.260
Annual treatment means:	3.016	4.228

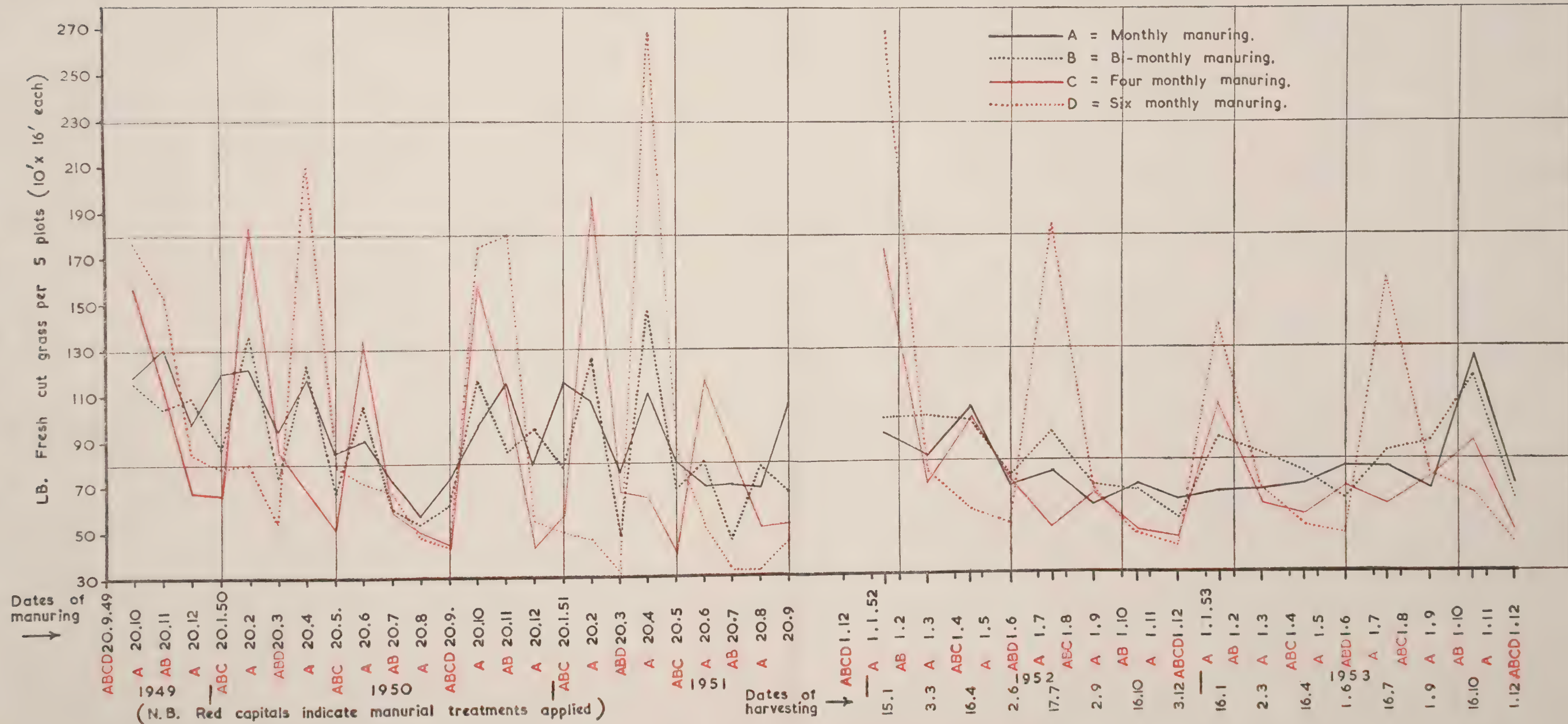
It is concluded from these results that mean yields of cut grass were not affected by the successive increases in frequency of fertiliser application from twice to 12 times per year.

Reference to Graph I shows that variation in the frequency of fertiliser application does, however, have a very pronounced effect on the pattern of yields from harvest to harvest; the more frequent the applications, the more uniform the pattern, and *vice versa*. There is also the indication that the response to fertilisers made by Guinea grass is mainly confined to the first harvest after manuring.

The most important result of this experiment, in relation to practical farming, is probably that the most uniform growth of grass over the year seems to be obtained by manuring at the same frequency as harvesting. The results are also important, however, in regard to the possibilities they suggest. The first of these is, of course, that annual yields might well be increased very considerably above the 30 tons per acre level by application of heavy fertiliser dressings after every harvest. Another is that the economic maximum for fertiliser application to fodder grasses may be very much higher than was suggested in the second article (2) of this series, judging from the results (1) of Experiment No. F.E.S.S. 68.

Graph I
Experiment F.E.S.S. 67

FREQUENCY OF MANURING GUINEA GRASS.
YIELD OF CUT GRASS PER HARVEST PER TREATMENT.



A further experiment which was carried out at the Federal Experiment Station, Serdang, provided confirmatory evidence that the effect of fertilisers on Guinea grass yields was mainly confined to the first harvest after application. It is proposed to outline only the relevant parts of this experiment (No. F.E.S.S. 118) in the present article. There were three manurial treatments in the trial, i.e. no fertiliser, a single dressing and a double dressing of a mixture comprising 3:1:3 parts by weight of sulphate of ammonia, superphosphate and muriate of potash respectively. The experiment lasted for two years. Manuring of the Guinea grass took place at three-monthly intervals and harvesting at 1½-monthly intervals. Manures were applied 1½ months before the first harvest and at a similar period before all succeeding alternate harvests.

Yields of grass per treatment are shown, arranged in groups of first harvests and second harvests after manuring, in Table III.

Table III.

Experiment No. F.E.S.S. 118.
Yields per Treatment per Acre for Groups of First and
Second Harvests after Manuring:
(tons fresh grass)

Groups of Harvests	No Fertiliser	Single Level of Fertiliser Application	Double Level of Fertiliser Application
Eight first harvests after fertiliser application	15.28	36.81	52.28
Eight second harvests after fertiliser application	11.48	16.51	18.76

These figures clearly confirm the indication that fertiliser effects on Guinea grass yields are mainly confined to the first harvest after application, and also add weight to the proposition that annual yields could be considerably increased above the 30 tons level by heavy fertiliser applications after each harvest.

Discussion.

The results of the experiments described in this series of articles have demonstrated two points of major importance. They have shown, first of all, that the conception of a limit on yields of about 17 tons per acre per year, as suggested by Simpson (3), is not necessarily correct; they have also demonstrated that yields of grass well above this limit can be obtained by

the application of fertilisers alone. The results have fallen short of expectation in that they have not shown how the second year fall in yields can be prevented, and they have only shown how yields of about 30 tons per acre per year can be obtained—a level which is low by standards of other tropical countries. They have also failed to clarify certain questions in regard to the use of fertilisers, for example, that of the need for phosphate. At the same time, the results have provided clear indications in relation to some of the problems which remain unsolved. They suggest that the second year fall in yields might well be prevented or, at the least, reduced by manuring with both animal manure and fertilisers. They indicate that the efficiency of both these manures would be improved by joint application, and they suggest that the key to further substantial increases in yield may well lie in the heavy application of manure after each harvest.

In short, it can be said that the experiments show that reasonable yields of fodder grass can be obtained by manuring in Malaya, and that the conception of systems of mixed farming involving the cultivation of these grasses is thereby brought nearer to practical realisation.

The possibility of systems of mixed farming raises issues of considerable importance, which will require investigation before such systems can be successfully evolved. How long, for example, can fodder grasses be economically cropped before replanting becomes necessary? Should replanting be carried out on new land or on the same land and, if the former, what systems of fodder and other crop alternation can be adopted? And, finally, having regard to the low protein content of Guinea grass, should the grass be grown in association with a legume, and, if so, how will this modify manurial requirements?

It might be argued that, while the evolution of mixed farming systems involving fodder grasses does seem to be practicable, such systems are unlikely to be adopted on any scale since they are so radically different from the systems now followed by the small farmer. This argument is not as forceful as would appear to be the case on the face of things. The idea of cutting and carrying grass for cattle feeding is part and parcel of farming in the large cattle-rearing areas in the north-east of Malaya. There, also, the periodic alternation of dry padi cropping with a grazing fallow is reasonably common practice, as, in addition, is the use of cattle dung for manuring dry padi and other arable crops. Mixed farming systems, involving cultivation of fodders in alternation with arable cropping, would not, therefore, be as radically different from present systems as might seem to be the case, and the increase in land productivity which they would bring about is one of the most urgent economic needs in the developed agricultural areas of the north-eastern States.

Summary.

It is suggested in this series of articles that fodder grass cultivation is of considerable potential importance in Malaya. A brief summary of some of the major conclusions of pre-war work on fodder grasses is given, and

post-war experiments at the Federal Experiment Station, Serdang, are described.

It is shown that yields of Guinea grass (*Panicum maximum*) can be raised in the first productive year from 16 - 20 tons to 30 tons per acre by the application of about 8 cwt. fertilisers. For Serdang soils, the most suitable mixture of fertilisers is said to comprise 8:3:6 parts by weight of sulphate of ammonia, superphosphate and muriate of potash respectively.

Grass yields are shown to fall seriously from the first to the second year of production, even when fertiliser application is maintained at a constant level, but some evidence is offered to indicate that the application of cattle manure in addition to fertilisers can reduce the extent of this fall, and is indeed a more efficient system of manuring than the use of either manure separately.

While some results of experiment are described which show that the yield response to sulphate of ammonia is reduced with increase in the rate of application beyond 4 cwt. per acre per annum, others are mentioned which suggest that this effect need not necessarily always operate.

Guinea grass is shown to make its main yield response to fertilisers in the first harvest after application, and it is pointed out that, in practice, application should therefore be made soon after every harvest so as to ensure an even flow of grass. It is suggested, also, that yields of well over 30 tons per acre per annum might be obtained by heavy manuring after each harvest.

The need is indicated for further investigation to solve specific manuring problems and to determine how fodder grass cultivation can best be fitted into farming systems. Finally, the importance of evolving such systems, particularly in north-east Malaya, is emphasised.

Acknowledgements.

The author has pleasure in acknowledging the very considerable assistance he has received from many officers in the Department of Agriculture in the preparation of these articles. He particularly wishes to acknowledge the patient, constant and expert guidance of Mr. I. Watson, Statistician, in all statistical matters. He is very glad, also, to express his appreciation of the practical help which Enche Mohamad bin Jamil, Agronomist, and Enche Mustaffa bin Talib, Junior Agricultural Assistant, have given in the work of assembling data and elucidating questions of practice.

References.

- (1) Henderson, R. (1955): "The Cultivation of Fodder Grasses in Malaya. Part I. Introduction"—*Malay. agric. J.*, **38**, 71.
- (2) Henderson, R. (1955): "The Cultivation of Fodder Grasses in Malaya. Part II. The Application of Artificial Fertilisers"—*Malay. agric. J.*, **38**, 141.
- (3) Simpson, H.J. (1940): "Manurial Experiments with Guinea Grass at the Central Experiment Station, Serdang"—*Malay. agric. J.*, **23**, 171.

MANILA HEMP: A VARIETY TRIAL AT THE FEDERAL EXPERIMENT STATION, SERDANG

BY

J. S. URE,

Agronomist-in-Charge,

Federal Experiment Station, Serdang.

Introduction.

Manila hemp (*Musa textilis*) is indigenous to the Philippine Islands, and introductions to Malaya from there took place as early as 1909 (1). An area of approximately 13 acres was planted at Serdang, Selangor, during 1922 and 1923, but this planting was not markedly successful as very few plants produced stems long enough to be of commercial value.

Three varieties have now been established in Malaya after introduction from the Philippine Islands; these are *Tangongon*, *Bangulanon*, and *Baguisanon*, which were reported to produce fibre superior in quality to that of the local type. A hybrid population of local origin was examined botanically in 1947 when three distinct genotypes were recognised and designated *Serdang A*, *Serdang B*, and *Serdang C*. These six varieties were grown in a variety trial laid down at the Federal Experiment Station, Serdang, in April, 1948, to compare their yields, fibre contents and habits of growth.

Description of Varieties.

Some characteristics of the varieties are listed in Table I.

Tangongon is a tall, sturdy variety capable of good performance even in poor conditions. It produces relatively few suckers but, at Serdang, these are of a good sword type. The stools tend to rise and eventually produce a high proportion of unproductive floaters. The extraction rate is good and the fibre produced is strong, if somewhat coarse.

Typically there is much deep-red pigment in the lower part of the pseudostem, giving a characteristic green-bronze tinge.

The variety is resistant to the fungus disease *Marasmius subplexifolius*.

Bangulanon is a shorter and more slender variety than *Tangongon*, and is reputed to be an excellent yielder when grown under ideal conditions. Suckering is free, but a high proportion of the suckers produced at Serdang are the unthrifty umbrella type. The extraction rate is satisfactory and the fibre produced is fine and lustrous.

Typically the pseudostems are heavily pigmented and of a uniform purple-black colour at the base with brown streaks above.

The variety is susceptible to *Marasmius subplexifolius*.

Table 1.

Some Characteristics of the Varieties of Manila Hemp Under Test.

	Tangongon	Bangulanon	Baguisanon	Serdang A	Serdang B	Serdang C
Average number of stems handled per acre per year*	1,046.65	307.34	412.01	1,224.52	2,871.33	1,738.77
Average yield of fibre per acre per year (lb.)	618	108	136	204	18	518
Fibre extraction rate (per cent) +	2.13	1.82	1.26	0.88	0.69	1.06
Average weight of a fresh stem (lb.)	36.5	30.4	32.4	24.1	12.0	33.2
Average length of a fresh stem	7' 2"	7' 0"	6' 10"	6' 3"	4' 9"	7' 1"

* These figures include many stems which were harvested and subsequently found to be too short for fibre extraction.

+ The fibre extraction rate over the period of the trial is not available as the weight of trimmed stems was not recorded. The figures given are based on measurements taken over a six-months period after the completion of the trial.

Baguisanon is similar to *Bangulanon* in size, colour, and growth habit. The extraction rate is low and the fibre produced is of average strength and quality.

The variety is slightly susceptible to *Marasmius subplexifolius*.

Serdang A has a very spreading growth habit. It suckers freely, producing stems shorter and thinner than the varieties mentioned above. The pseudostem is green, carrying a little brown pigment at the base. The extraction rate is poor and the fibres tend to be short and brittle. It is slightly susceptible to *Marasmius* stem-rot.

Serdang B is a profusely suckering variety, producing stems which are mostly too short to be of value. The extraction rate is very low and the fibre is short and of poor quality. Like *Serdang A*, pigmentation of the pseudostem is slight. *Serdang B* is very susceptible to *Marasmius subplexifolius*.

Serdang C. This variety suckers freely and produces many long and thick stems and is fairly resistant to the stem-rot. The extraction rate is low. The fibre is fine and soft. The pseudostem base is heavily pigmented.

Management.

Manila hemp thrives best on coastal alluvial or deep inland soils and was grown at Serdang, on an area of rather poorly drained, black, silty loam, only with the aid of chemical fertilisers. That the drainage was insufficient and the acidity too high was realised during 1951, and improvements were made by deepening the drains and applying nine tons per acre of limestone dust. Weed control in the very early stages was attempted by mulching with cut grass but, once the crop was established, clean weeding was practised. Initially, desuckering was carried out to allow 15 good stems per stool to develop but, as this resulted in the production of stems of unsatisfactory size, later in the trial only 10 stems per stool were allowed to develop. Routine manuring consisted of an application of 10 cwt. per acre per annum of a mixture of sulphate of ammonia, single superphosphate and sulphate of potash in the proportions 1:2:2. This mixture was applied in two half-yearly dressings.

The site was not ideal topographically, and the experiment was handicapped from its inception by considerable leaf scorch, probably caused by exposure to wind.

Experimental Procedure.

The experiment consisted of six randomized blocks of six varieties, each plot containing 15 stools planted at 10 x 10 ft.

Some stems were harvested during 1949, but extraction of fibre was not commenced until November, 1950. A Hagotan was used for all extractions, and with this particular machine the minimum stem length for extraction was about 5 ft. This machine has been described by Boyce (2). Yields of fibre were recorded for four years, from November, 1950, until October, 1954, and the results are given in Table II. The figures show that, though the overall yield of fibre was very low, *Tangongon* and *Serdang C* gave yields significantly higher than the other varieties.

Table II.

Yield of Fibre from Four Years Extraction

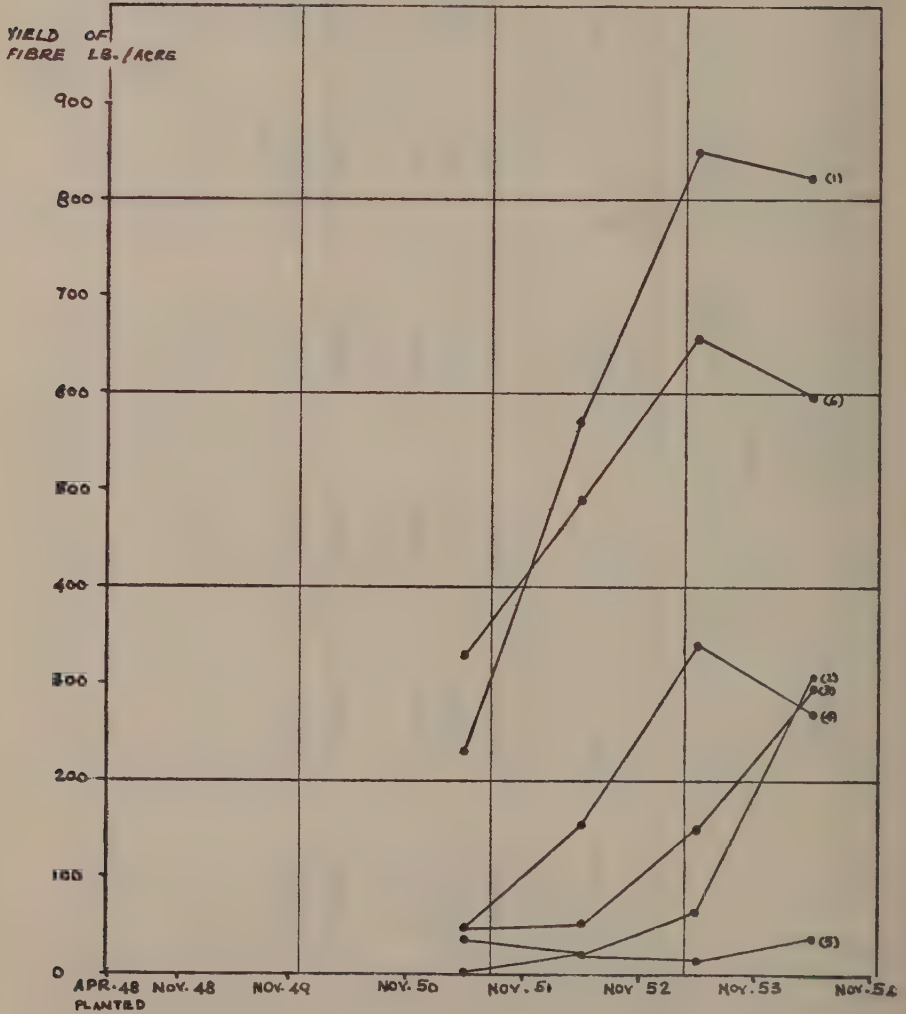
(oz.)

(Figures in brackets are calculated yields inserted for missing plots)

Variety	Tangongan	Bangulanon	Baguisanon	Serdang A	Serdang B	Serdang C	Total
Block No.							
I	1,464.75	(225.25)	(288.50)	456.50	(95.50)	1,066.25	2,987.50
II	1,413.25	287.50	87.00	565.75	55.00	1,135.00	3,543.50
III	1,078.25	283.00	(180.00)	409.50	4.25	989.50	2,764.50
IV	877.50	(55.75)	246.00	294.50	13.50	1,090.25	2,521.75
V	1,575.00	(293.50)	170.25	434.00	89.50	1,442.75	3,711.50
VI	1,767.00	143.50	695.50	541.50	(250.75)	1,130.25	4,277.75
Total	8,175.75	714.00	1,198.75	2,701.75	162.25	6,854.00	19,806.50
Yield per acre per year (lb.)	618	108	136	204	18	518	Average 267

FIGURE I
YIELD OF FIBRE FROM SIX VARIETIES OF MANILA HEMP
FOR A PERIOD OF FOUR YEARS

- (1) Tangongon
(2) Bangulanon
(3) Baguisanon
(4) Serdang A
(5) " B
(6) " C



Discussion.

The variety *Tangongon* appears to be slightly later in coming into bearing than the variety *Serdang C* (Figure I), but this is significant only at the 5 per cent point. The difference in time to maturity may be greater than is indicated, but this cannot be ascertained as extraction commenced only when the crop was 32 months old. Records of the numbers of stems harvested prior to this are of little value, as suckering was controlled and many of the stems produced would have been too short for fibre extraction had this been attempted. Though these results indicate that *Serdang C* is comparable with *Tangongon*, it should be pointed out that this is true only in respect of the production of fibre per acre. The commercial value of the variety *Serdang C* is reduced because it produces more numerous and smaller stems than the variety *Tangongon* and because the fibre extraction is much lower. The number of stems to be handled is obviously an important factor in the economics of processing, and though no investigations have been carried out on this subject, it is evident from the figures in Table I that a greater labour charge would be involved in handling and stripping *Serdang C* compared with that for *Tangongon*.

Conclusion.

Of the three recognised varieties, only *Tangongon* gave a reasonable yield, *Bangulanon* and *Baguisanon* being unsatisfactory in stem production and inferior to *Tangongon* in fibre content.

All the *Serdang* varieties suckered more profusely than the commercial varieties, but both *Serdang A* and *Serdang B* produced short stems with an unsatisfactory fibre content. *Serdang C* showed some promise as, though the fibre content is only half that of *Tangongon*, the number and size of stems produced was satisfactory, thus producing a yield of fibre per acre which was comparable with that of *Tangongon*.

Summary.

A variety trial of six varieties of Manila hemp is discussed, and it is concluded that the two best-yielding varieties are *Tangongon* and *Serdang C*. It is considered that *Tangongon* is superior to *Serdang C* because handling costs are less owing to the production of fewer but larger stems of high fibre content.

Acknowledgements.

The writer wishes to acknowledge the assistance of Mr. A. L. Barcroft and Mr. E. A. Rosenquist, whose unpublished work on this subject has been utilised in the compilation of this report.

References.

- (1) Bishop, R.O. and Curtler, E.A. (1925): "Preliminary Notes on Manila Hemp"—*Malay. agric. J.*, **13**, 125.
- (2) Boyce, D.S. (1954): "The Development and Design of a Hagotan for the Extraction of Manila Hemp Fibre"—*Malay. agric. J.*, **37**, 218.
- (3) Marsh, T.D. (1947): "Manila Hemp (*Musa textilis*)"—*Malay. agric. J.*, **30**, 123.

NOTES ON CURRENT INVESTIGATIONS (RESEARCH)

JULY TO SEPTEMBER, 1955

Compiled by the Acting Chief Research Officer

Owing to expansion of the field of research the following notes have had to be restricted to cover only a few of the points of interest which have arisen during the past quarter from the technical investigations in progress. It may be assumed that work referred to in previous reports but not mentioned here is still in progress. A number of the new investigations undertaken also have had to be omitted.

Padi.

VARIETY SELECTION.

Indica x Japonica Hybrids.

Off-season crops of representative families of the *indica* x *japonica* hybrids were grown at the Padi Experiment Stations at Bukit Merah, Province Wellesley, and Pulau Gadong, Malacca, to assess the proportion of 'period-fixed' strains occurring. In all cases 100 per cent flowering was reported within a reasonable period, which suggests that a selection programme can be undertaken at Bukit Merah to produce suitable strains for use in the off-season.

Seeds of progenies for the 1955-56 season have been sown at Telok Chengai, Kedah, and much improved germination is reported this year due to the improved seed storage conditions which were provided after harvest of last year's crop.

Extension Trials.

Results have been received from Pahang, Kedah, Perak, Malacca and Negri Sembilan and are in the process of analysis. Provisional observations indicate that in no cases did the new variety under test fail to outyield local varieties. In general, significant increases are evident.

INDUCED MUTATION.

X-Rays.

A recent report from U.S.A. claimed a high proportion of strong strawed mutants in cereals by use of X-rays. The method used and dose recommended have been tried on germinating seeds of Siam 29 (the X-ray apparatus was supplied by kind permission of the Medical Department). The immediate conclusion is that the dose (25 R units) is too high for rice, as the majority of the seedlings failed to develop any further after irradiation. The investigation is continuing.

Colchicine.

In order to develop a standard technique for production of polyloid padi varieties, investigations with colchicine solutions on germinating seedlings have been started. By soaking seedlings in a 0.2% solution of colchicine for 3 hr. at 27°C., it is provisionally estimated that approximately 25 per cent of the material has been affected. A time less than 3 hr. with this concentration appears inadequate.

CYTOLOGY.

Cytological studies on cells from root tips of *Oryza ridleyi*, a wild rice of Malaya, indicate that this species is a tetraploid. This will be confirmed after examination of chromosome number at microsporogenesis.

NUTRITION.

Major Elements and Toxicity.

Sand culture experiments have been commenced:-

(a) to investigate foliar symptoms of deficiencies of the major elements nitrogen, phosphorus, potassium, calcium, magnesium and iron;

(b) to determine the toxic level for iron and aluminium and to record symptoms produced by high concentrations of these elements. The former difficulty experienced in retaining high concentrations of iron in solution has been overcome by using chelated iron; and

(c) to study varietal tolerance to toxicity by arsenic and sodium as sodium chloride. The arsenic problem is liable to occur in the vicinity of tin mines. Varietal tolerance to salinity varies and information on threshold values of toxicity will assist in recommending varieties for use in coastal areas where sea encroachment is frequent.

pH.

An experiment to determine the effect of pH on the growth of padi is in progress and pH levels of 2.5, 4.0, 5.5, 7.0 and 8.5 are being used. After eight weeks, plants in all treatments are still alive, but in the lowest pH (2.5) treatment most of the leaves have died off suddenly. The difficulty of maintaining the requisite pH has been overcome by using drip cultures from large (15 litre) reservoirs.

Photoperiodism.

A new experiment has been started to study the effect of different day/night lengths on growth and flowering behaviour of the variety Siam 29. A previous experiment has suggested that the flowering stimulus is not transferred from the oldest to the younger tillers. Dissection of apices of Siam 29 growing under natural day has shown that the change from vegetative to flowering apex takes place in the two weeks when the total change in natural day length was 1 min., from 12 hr. 12 min. to 12 hr. 11 min. Thus 12 hr. 12 min. is probably the critical day length for this variety.

DISEASES.

Penyakit Merah.

In connection with investigations into the cause and amelioration of *penyakit merah*, fertiliser trials using both soil and foliar applications have been laid down at 19 different localities. Varietal trials have also been laid down on six padi experiment stations to provide further evidence of suspected resistance. A trial to assess the effect of water stagnation on the incidence of *penyakit merah* is in progress in tank cultures in Kuala Lumpur.

Seed Infection.

The use of organic mercurial seed dressings in field nursery trials has been commenced to follow up laboratory tests. Studies of the seed fungal flora show *Helminthosporium oryzae* to be present in almost all samples and *Trichoconis padwickii* to be common; other isolates newly identified include *Pestalotiopsis disseminata* and *Trichothecium roseum*.

PESTS.

The increase in stem-borer infestation has been found to be negligible until at least one month after transplanting. The Staphylinid beetle *Paederus fuscipes* Curt.—reported in 1932 as attacking stem-borer eggs—has been observed to be a predator of newly hatched stem-borer larvae in the field.

EXPERIMENTS WITH INSECTICIDES.

Within 20 hr. of application the following insecticides proved lethal to the serpent head fish or *aruan*, *Ophiocephalus striatus*:—endrin at 0.00045 p.p.m., dieldrin at 0.0079, D.D.T. at 0.04 and gamma BHC at 0.32 p.p.m. Only the last two insecticides can be considered for use in the field against stem-borers due to their lower toxicity to fish in padi fields.

SOIL SURVEYS.

Surveys of potential padi areas have been carried out in the Kuala Langat area of Selangor, which has proved to be largely covered by acid peat; in the Changkat Jong area of Perak, where provisional recommendations have been made for extension of padi cultivation over a further 1,100 acres; and at Paya Berhala Kayu, Trengganu, where soil and drainage conditions proved unpromising.

Tests of disturbed samples of sulphurous soils from Tanjong Minyak, Malacca, indicate that a high degree of impermeability may impede treatments aimed at amelioration. Further tests are to be undertaken *in situ*.

Cacao.

BREEDING.

Some 200 pollinations have been made towards the production of seed for progeny trials of selected trees. Seed of 17 different progenies has been sent to Jerangau, Trengganu, and satisfactory germination has been reported.

In spite of improvement of bean size with age of tree in some progenies, their yields are still poor as compared with Amelonado in duplicated trials.

Multiplication of 31 initial selections and eight I.C.S. clones has been carried out. Seven hundred pollinations for compatibility testing have been mainly confined to selections for clonal propagation.

DISEASES.

Different types of leaf rim blight have been induced in sand culture by calcium, potassium and magnesium deficiencies, necrosis appearing at about three months after planting. The pathogenicity of the fungi, *Phyllosticta theobromae* and *Physalospora theobromae* commonly associated with such leaf symptoms, is considered doubtful.

Marked symptoms of zinc deficiency have been recorded in the field.

PESTS.

Pod damage by rodents and other jungle animals is increasing and has so far only been controlled by mechanical protection of the pods.

In addition to the larger *Zeuzera conferta* and more common *Z. coffeae*, a third species, *Z. roricyania* Walk., has been found boring cacao in Malaya.

The clear-wing moth causing damage to pods and seed has been identified as *Conopia* sp. Severe defoliation of Amelonado by the Limaedid *Orthocraspeda trima* Moore occurred in a small area but was controlled by fogging with DDT and spraying with lead arsenate.

PROCESSING.

A satisfactory microfermentation technique has been worked out for determining single pod yield of dry cacao. The method is now being developed with a view to flavour control and a study of pigment development by paper chromatography.

A triple-roll mill for chocolate preparation has been put into use and satisfactory chocolates have been made from Amelonado cocoa. Favourable commercial reports have been given on bulk fermented samples.

SOIL SURVEY.

Detailed soils maps of a number of potential cacao areas in Trengganu and Pahang have been completed and reconnaissance surveys are still in progress in other areas in these States. These include a number of extensive basaltic areas which should prove eminently suited to this crop.

Oil Palm.

BREEDING.

Recent work has been concentrated on extending the genetic range of Dumpy material by hybridisation with low statured palms selected on estates, and by increasing *pisifera* progenies for selection of fertile segregants.

Progeny trials established on estates in the last few years are beginning to come into bearing. The first four months' records of 3½-year-old palms show little difference in yield between Dumpy and Dumpy x tall backcross progenies.

DISEASES.

Leaf spotting due to *Curvularia* and *Gloeosporium* has been reported from a new locality.

NUTRITION.

Leaf analyses of samples of differing ages from three estates have been undertaken to relate nutritional status to soil types and fertiliser requirements.

Coconut.

SELECTION.

A total of 1,535 nuts has been harvested from the selected trees at Port Swettenham, and 903 germinated nuts are now in the nursery at Degong Experiment Station, Perak.

PESTS.

Replicated tests on *Oryctes rhinoceros* larva in boxes of sawdust showed that, 20 days after spraying, Aldrex, Dieldrex and BHC all caused at least 90 per cent mortality.

Pineapple.

SELECTION.

Initial single plant selections have been made in the selection blocks of the Sarawak variety growing at Jalan Kebun Experiment Station, Selangor.

DISEASES.

Both Fruit Collapse and Heart Rot have been proved by controlled cross inoculation tests to be caused by the same bacterium, a species of *Erwinia*, which is present in all cases of these diseases so far investigated. The disease, hitherto recorded only from Johore, has now appeared in Selangor, where the same pathogen is responsible.

PESTS.

Attempts to exclude mealy bugs (*Dysmicoccus brevipes*) from uninfested areas by fumigation of planting material with either hydrogen cyanide or methyl bromide have been unsuccessful. The pest appeared in the treated plots in small numbers within a month or two of planting.

PROCESSING.

A start has been made to study the chemistry of development and maturation of pineapple fruits. These studies are also related to the effects of fertilisers, particularly potash, and will in due course be accompanied by analyses of leaf tissues.

The use of filtered juice to replace part of the canning syrup is being investigated.

A series of trials on canning juice of the Singapore Spanish variety has been undertaken and so far has shown that cores and whole skins are unsatisfactory for the purpose, the best juices arising from discarded pulp, "tops and tails" and trimmings; and the best quality fruit gave the best juice. The best of the juices so far prepared were however lower in sugar and acid content than first quality standard commercial brands.

Definite progress has been made towards solution of the paraffin off-flavour problem. Though staling of fruit between harvest and canning does not affect off-flavour, prolonged exposure to the air of the cut fruit before processing increases its development in subsequent storage. There is evidence of an off-flavour "precursor" generated by adverse growing conditions.

Other Crops.

VEGETABLES.

For the control of Late Blight (*Phytophthora infestans*) at Cameron Highlands, Bordeaux mixture has proved superior to four other copper and organic fungicides.

CITRUS.

White root disease (*Fomes lignosus*) has been recorded for the first time on citrus, the host being *limau kasturi* (*Citrus microcarpa*).

CLOVE.

The *Cryptosporella* causing die-back of cloves in Penang has been found causing a similar disease in the related species *jambu ayer* (? *Eugenia aquea*).

KAPUR.

A species of the gall midge *Asphondylia* is newly recorded as causing extensive damage by gall formation to the branches of a Kapur tree (*Dryobalanops aromatica*).

Termites.

Polythene-sheathed electric cables exposed in the soil to attack by *Macrotermes gilvus* suffered only slight external scarification after one year. Of the internal wires, those coloured white or orange were least, and the grey and brown ones most damaged. The same insect, which rapidly destroyed untreated meranti wood, caused negligible damage to tanalised meranti after 19 months exposure.

Laboratory Techniques.

CATION EXCHANGE CAPACITY.

Research has narrowed the possible methods of estimating cation exchange capacity down to two, using (a) ammonium acetate and (b) barium chloride buffered by triethanolamine. Results with both have been in close agreement and investigation is continuing to decide which is the better suited to routine use.

NOTES ON CURRENT INVESTIGATIONS (AGRONOMY)

JULY TO SEPTEMBER, 1955

Compiled by the Senior Agronomist.

Padi.

In Kelantan, padi occupies 180,000 acres of land, or approximately half the total area of cultivated land in the State. Rubber, the next most important crop, occupies 100,000 acres.

Experiments have shown the value of manuring in Kelantan and the need for the three major elements—nitrogen, phosphorus and potassium. The present East Coast fertiliser mixture supplies these elements and it gives very good results, particularly on the lighter soils. Experience has shown, however, that it is not the ideal mixture for all soils nor is the recommended dressing of 200 lb. per acre the most economic for all areas. In order to investigate these problems in greater detail, four new, complex trials have been laid down this season on padi stations representative of the main soil types in the region. At the same time, other agronomic trials are being continued, both on padi stations and on smallholders' land.

Intensive agronomic investigations continue in the Kedah-Perlis plain and are concerned with trials of different types, different ratios and different amounts of fertilisers and of the effects of different spacings and the use of different varieties in the presence and absence of fertilisers. From this season onwards it will be possible to correlate experimental results with soil type since a comprehensive soil survey of the Kedah-Perlis plain was commenced this year and has already made good progress.

Observations on nursery manuring experiments have shown that those seedlings which have been treated in the nursery with ammonium phosphate may be up to 1 ft. taller at the time of transplanting than unmanured seedlings. This is important where depth of water is a limiting factor to age at transplanting, as in parts of Pahang.

Simple 2-plot demonstrations of nursery manuring using Ammophos 11:48 at the rate of 2 lb. per gallon of seed were carried out on 10 small-holdings in Province Wellesley during the off-season. The *japonica* variety used was Pe Bi Fun and yields were low because of water shortage. They were as follows:-

Nurseries manured	=	1,168 lb. per acre of grain
Not manured	=	946 lb. per acre of grain
Difference	=	222 lb. per acre of grain

The increase in yield was worth about \$21 to the planter and was obtained by spending about \$2 on fertiliser. At the Bukit Merah Padi Experiment Station, where pump irrigation was available, the increase amounted to 320 lb. per acre, worth \$30. It is clear that this is a most promising development.

The Kelantan dry padi variety Jintan Manis is being used in current trials on bog soils in the Tanjong Karang area of Selangor because of promising yields last year. On such soils, liming, burning and application of phosphate appear to be of marked benefit.

Cacao.

Now that the "Report of the Working Party set up to consider the Development of a Cacao Industry" has been published, the Department has recently given considerable publicity to the potentialities of this crop. At the Twentieth M.A.H.A. Exhibition held in Kuala Lumpur in August, cacao was given pride of place in the large Departmental exhibit. Growing trees were displayed together with suitable shade and nurse crops, and every stage of cultivation and processing was demonstrated from sowing the seed in baskets or veneer tubes to manufacture, by the Chemistry Division, of plain and milk chocolate. Also, current field research was illustrated by a comprehensive series of photographs.

A revised leaflet on cacao has been prepared and is now in the press. A simple precis of this has been made for translation into the Malay and Chinese languages.

It has recently been discovered that certain forest trees are unsuitable for use as cacao shade since they suppress the growth of the crop. The common *Meranti Tembaga* is the chief offender in the Jerangau area of Trengganu, this tree being particularly common in that area. This discovery, although recent, has already been of extension value since it has been decided to eliminate this species when carrying out selective forest thinning prior to planting cacao.

The Senior Agronomist attended the Cocoa Conference in London in September and amassed a great deal of information from discussion with workers from other countries. It was particularly interesting to note that the observed benefit of manuring with ground magnesium limestone at Jerangau ties up with soil analysis studies carried out in the Gold Coast, where the importance of magnesium and calcium is now being emphasized. At this conference, 24 large photographs illustrating cacao cultivation in Malaya were on display and they aroused considerable interest.

A guide to the Federal Experiment Station, Jerangau, has been prepared and cyclostyled. This includes a detailed soil map prepared by the Soils Division of the Research Branch.

The new halting bungalow at this Station was opened by the Director of Agriculture during the quarter and an Agronomist has been posted there. All quarters now have a piped water supply.

A simple experiment has confirmed the value of using some double superphosphate in basket composts in preference to a double dressing of rock phosphate.

It is already clear from a bare-root seedling experiment that soft treatment gives better results than hard nurseries. The former are standard nurseries on rich soil; the latter are close-spaced, with the minimum of shade and situated on sandy alluvium.

Coconuts.

Twenty squirrels have been shot in the immediate neighbourhood of the simple manurial experiment at Batu Rakit, Trengganu. The third half-yearly manurial dressing was given in August, and consisted of the following fertilisers:-

sulphate of ammonia	- 3 lb. per palm
Christmas Island rock phosphate	- 2 lb. per palm
muriate of potash	- 1 lb. per palm

Harvests carried out in July and September yielded the following numbers of nuts:-

Treatment A - full NPK dressing	- 344
Treatment B - half NPK dressing	- 165
Treatment C - control, no fertiliser	- 102

Oil Palms.

Harvesting commenced in September in Trial Tr.29 at the Federal Experiment Station, Jerangau, which was planted three years ago, and 327 bunches, weighing 2,240 lb., have been recorded.

A 20-acre clearing for a new trial on the same station had a poor burn because of showery weather and planting out will be delayed.

Fibres.

A Manila hemp variety trial has been concluded at the Federal Experiment Station, Serdang, since Tangongon had been shown to have the best performance of all varieties tested and this is in line with experimental results from other localities. As a logical development, a half-acre nursery has been established on good soil at this Station and the hemp has shown very satisfactory growth.

Pineapples.

The second harvest from a rate of potash trial at the Federal Experiment Station, Jalan Kebun, Selangor, emphasizes the importance of this nutrient for the Singapore Spanish variety. This is illustrated by the summary below:-

Rate of Potash per Annum (lb. per acre)	Yield of Fruit (lb. per acre)	Average Fruit Weight	
		lb.	oz.
0	7,532	2	10
50	8,496	2	15
100	9,654	3	$\frac{1}{2}$
150	10,450	3	4 $\frac{1}{2}$
200	9,272	3	$\frac{1}{2}$

The optimum application would seem to be 150 lb. per acre of potash, which is equivalent to 250 lb. per acre of muriate of potash.

Fruiting control trials at Jalan Kebun have indicated that both carbide and "A.N.A." (alpha naphthalene acetic acid) can be used to induce flowering of Singapore Spanish pines but that the former treatment leads to larger and more advanced fruit than on plants treated with hormone. However, Sarawak plants 17 months old have not shown full response to either treatment, although carbide showed some superiority over "A.N.A.".

A manurial spray trial has been laid down on a crop of Singapore Spanish pineapples planted in October, 1952. The first treatments, which compare various rates of spray application with a dry application of fertiliser, were put on in August.

Tea.

Tea rooting trials in special beds under *Erythrina* shade at Serdang have given 70 to 100 per cent rooting with good cutting material.

Tobacco.

Tobacco is the latest crop to be harvested from a rotation experiment on deep peat soil at the Federal Experiment Station, Jalan Kebun, Selangor. The other crops include maize, kangkong and ginger.

Vegetative growth of the variety White Burley was very promising but the quality suffered as a result of a serious attack on the leaves by "Frogs Eye Spot" caused by the fungus *Cercospora nicotianae*. The yield of cured leaf was 595 lb. per acre, and the leaf was sold at the low price of \$60 per pikul (133½ lb.), perhaps because of unsatisfactory curing.

Tobacco is undoubtedly a promising crop for peat but it clearly requires more investigation before it can be recommended for these soils. For one thing, it would seem to require a higher level of potash nutrition than it received in this trial.

Pastures.

Planting material of two very promising East African grasses has recently been imported from Ceylon. These are:-

Panicum trichocladum

Brachiaria brizantha

Both species are prostrate, with a spreading, vigorous habit. They are being bulked up as rapidly as possible.

Food Crops.

In a lowland cauliflower variety trial carried out in Kuala Lumpur, only the two control varieties produced heads. These were as follows:-

Variety	Yield of Trimmed Curds (lb. per acre)	Average Weight (lb.)
Early Patna	1,910	3.8
Early Market	2,390	4.8

It is questionable whether cauliflower cultivated on the lowlands can ever compete with the highland product.

A similar trial at Cameron Highlands showed that the best variety was Sutton's Snowball, with Snowdrift 16 second, followed by Early Snowball 34A, Snowdrift 14 and Burpeeana, in that order.

Derris.

A cultural trial with Sarawak Erect and Sarawak Creeping varieties is now being planted at Jalan Kebun on deep peat. The erect variety has proved to be easier to root and establish than the creeping one.

Observation plots on the same station have shown that Changi No.3 is much more vigorous there than on mineral soil at Serdang.

Fruit.

Investigations at Serdang on propagation methods have shown that old mature rambutan budwood (9 months or more old) was superior to young material and that size alone was no criterion of value. Mature budwood about the size of the middle finger is probably best.

For rambutan budwood, natural petiole abscission induced by removal of the leaf 14 days before cutting is absolutely essential.

Variations in the panel design of the modified forkert system of budding have not proved to be superior to the standard method. Removal of the flap after budding depresses "take." It has also been demonstrated that wide bud-patches are desirable since narrow ones give a poor "take".

The use of healthy, actively-growing young root stocks which reached buddable size towards the end of August raised the percentage take from 25 to 92 and served to indicate that good horticultural practice is the answer to the problem.

Livestock.

Pigs.

At Pulau Gadong, Malacca, the experimental Wessex boar served 16 sows during the last quarter. Six half-breds weighed 702 *katis* (156 lb. each) when 6½ months old. They killed out at 70 to 72 per cent and the carcase quality was reported to be satisfactory.

Goats.

At Serdang there were nine births and 16 deaths during the period under review. The deaths included 11 cases of acute diarrhoea, so certain experimental green fodders are being excluded from the rations.

MECHANISATION

HALF-YEARLY REPORT, APRIL TO SEPTEMBER, 1955

Compiled by the Agricultural Engineer.

Recent Importations.

The following implements and machines have been received:-

Bentall All Metal Winnower, Mk.W.A.1.,
Trehwella "Monkey" Grubber hand-operated winch,
Ferguson Disc Plough,
Swingfog Pest Control Unit, SN.6,
Matsuyama Reversible animal draught plough,
Shabash animal draught plough.

Tests and Modifications.

BENTALL ALL METAL WINNOWER.

The Bentall All Metal Winnower is a conventional machine in which the grain is cleaned by a combination of sieving and winnowing. The sieves provided were not suitable for the somewhat small-grained padi used during the tests: in particular the weed seed screen had to be blanked off because the mesh was too large and the padi passed through. The Winnower can be hand-operated or driven by a small air-cooled engine: the latter source of power was used during the trials but the reduction gear and bearings supplied did not appear to be entirely suitable for power operation as the machine was extremely noisy and vibration was serious.

Approximately four tons of padi was cleaned during the trials. Outputs varied from 300 to 800 lb. per hr. depending on the dirtiness of the sample. 'Blind' or empty grains could only be removed if the padi was thoroughly dried before cleaning.

SWINGFOG PEST CONTROL UNIT SN.6.

The Swingfog Pest Control Unit is a simple machine designed to produce a fog of insecticide-bearing oil droplets of about 10 to 20 microns diameter. Under suitable atmospheric conditions this fog can be made to stay near the ground and drift down-wind covering a large area. The fog is only effective against insects with which it comes in contact and has no residual effect, so that the Swingfog complements, rather than replaces, conventional sprayers.

The Swingfog Pest Control Unit is mechanically simple: power is derived from a petrol-burning pulse-jet unit which has only one moving part—a plastic diaphragm—and which, once started, is self-sustaining and requires no ignition system. The oil-based insecticide is fed through filters and metering devices into the exhaust of the pulse-jet where it is broken up

by turbulence into very fine droplets which issue from the nozzle as a fog or mist. The temperature of the exhaust is quite low, no burning takes place and the fog, although it has the appearance of smoke, is composed of droplets of unburnt oil.

The latest model of the Swingfog, the model SN.6, differs from the earlier models, one of which has been in routine use for the Department since 1953, in that it is fitted with a coil and sparking plug for starting in place of a heater coil; this new system draws a comparatively small current and allows a small 'dry' accumulator, weighing only 2 lb., to be used for starting. The size of the droplets is controlled by varying the flow of oil to the nozzle, large flows giving large droplets and *vice versa*: in the earlier models the flow of oil was controlled by an adjustable valve, but the model SN.6 may be used either with an adjustable valve or with one of the six, non-adjustable jets provided. The SN.6 is also supplied with a spraying nozzle which can be used with water-based formulations; when this attachment is fitted the Swingfog is converted into an air-blast sprayer and can be used for deposit or residual spraying.

The Swingfog Pest Control Unit SN.6 is easier to start and appears to be capable of giving a higher output of fog than the earlier model. The starting battery is easily carried and the provision of non-adjustable jets in place of the adjustable valve is convenient where semi-skilled labour is employed. The new pulse-jet unit is well shielded and the Swingfog can be used for long periods without undue discomfort, although the working hours are normally limited by atmospheric conditions rather than by operator fatigue.

The spraying attachment is efficient and provides a fine, even spray but the output is low (2½ to 6½ gal. per hr.) and the Swingfog is not suitable for spraying large areas.

The Swingfog Pest Control Unit is a simple machine which can be maintained and operated by semi-skilled labour. Provided that the limitations of fogging are appreciated, it is an extremely useful machine, especially where the terrain or crop conditions prevent the use of more conventional sprayers and dusters.

HAND SCUFFLER.

A simple hand scuffler or hoe has been developed for nursery work. The frame of the hoe is made from ½ in. pipe and a small iron wheel is fitted. Spike tynes or "L" hoes may be attached to the frame. The scuffler greatly increases the rate of inter-row weeding in nursery crops.

COFFEE MANGLE.

An improved version of the hand-operated coffee pulper has been constructed. A crew of three men can process 900 lb. of Liberian berries per hour with the de-husker, which has a hardwood frame and a fabricated steel roller.

Investigations into the Cultivation of Wet Padi.

PRELIMINARY INVESTIGATION INTO THE IMPROVEMENT OF INDIGENOUS IMPLEMENTS.

Samples of the different types of animal-drawn ploughs in use in different parts of the Federation of Malaya have been collected and their characteristics analysed and recorded. A simple survey of the construction, cost, useful life and annual usage of the implements has been made in Malacca.

A number of modified mouldboard ploughs, with bodies of European-type fitted to local frames, have been constructed but none has proved satisfactory in field trials.

PRELIMINARY TRIALS OF IMPORTED ANIMAL-DRAWN PLOUGHS.

Nine types of animal-drawn plough, imported from Japan and India, were given preliminary trials in Malacca. Considerable experience of the technique of testing was obtained and it was clear from the interest shown by local ploughmen that the introduction of an improved plough would present no difficulty provided that it was cheap enough. The Indian ploughs were difficult to control, and the main disadvantages of the Japanese ploughs were their weight and the difficulty of carrying them to the field.

Mechanised Padi Farms.

The possibility of growing wet padi on small farms equipped with mass-produced tractors and their associated implements is to be investigated in a pilot scheme in Perak. Experience has shown that small tractors can only be employed economically when the level of the water can be accurately controlled, and it is hoped that it will be possible to obtain complete water control on the site which has been chosen near Parit, Perak, in Stage I, Trans-Perak River Irrigation Scheme, since it is bounded on the east by the main irrigation distributory, which is fed by a pump, and on the west by the main drain. The 150-acre block contains both primary and secondary jungle, and some 25 acres of the latter was cleared with a D4 tractor during September. The debris is being piled in windrows at two chain intervals but burning has been hampered by rain.

Publications.

A copy of the *Directory of Wheel and Track-Type Tractors Produced Throughout the World* has been received. The Directory, which is published by the Food and Agriculture Organization of the United Nations, includes details of the dimensions, power and speeds of 523 types of tractor manufactured in 13 countries. Although trade directories are published in many countries, this new publication, with its world-wide coverage, provides a convenient reference list for all who are interested in agricultural tractors, especially since prices are quoted in the majority of cases.

NOTES ON EXTENSION WORK

JULY TO SEPTEMBER, 1955

Compiled by the Acting Chief Field Officer.

Rubber.

With the advent of wet weather, planting again became possible in all States and Settlements except Trengganu and Kelantan, where the weather remained dry. During the period under review the number of clonal stumps delivered to the Rubber Industry (Replanting) Board for distribution to approved replantings totalled 1,040,607, and a further 52,700 stumps were distributed for new planting. This brings the totals to-date this year to 1,781,896 stumps for replanting and 202,648 stumps for new planting, valued at \$297,681.

As a result of the improved rubber prices during the year, smallholders have been less willing to cut out their old trees and to replant. This has had the general effect of slowing down the replanting programme which in turn has released a large number of clonal stumps, surplus to the Rubber Industry (Replanting) Board's requirement, which can now be used for new plantings.

In Johore and Negri Sembilan, smallholders have resorted to ladder and slaughter tapping and the use of latex stimulants in order to obtain the maximum benefit from the high price, prior to losing their trees to replanting. On the other hand, in Selangor the replanting programme is some 500 acres more advanced than at the corresponding time last year. The replanting programme is also fairly well advanced in Malacca and Negri Sembilan, but is lagging in all other States and in Province Wellesley.

Budgrafting on smallholdings appears to be gaining in popularity, especially amongst the Chinese in parts of Pahang and Perak. During the quarter, 33,564 yards of budwood of approved clones was delivered to the Replanting Board and 16,468 yards was distributed for new planting. These figures bring the totals to-date this year to 88,152 and 48,765 yards respectively, valued at \$34,299.

In terms of acreage planted, the foregoing figures represent a distribution during the quarter of sufficient planting material to establish 5,229 acres of replanted and 843 acres of new planted rubber, which brings the totals for the first nine months of 1955 to 11,664 and 3,207 acres respectively.

The most popular clone is now P.B.86, except in Ulu Trengganu where R.R.I. 501 is still preferred. There has been a marked swing from R.R.I. 501 to P.B.86 during the last two years, and this change has tended to lead to a local shortage of P.B.86 and a large surplus of R.R.I. 501 budwood in certain States. In order to overcome these difficulties and to improve generally the overall position regarding the production of budwood, so that the needs of both the Replanting Board and those of new planting will always

be met, no matter how great an expansion takes place, new budwood nurseries have or are about to be established in all States and Settlements.

Seed started falling early in the quarter and in spite of heavy demands on the commercial market some 5½ million clonal Tj. 1 seed have been collected and sown in nurseries to provide stumps for distribution to the Rubber Industry (Replanting) Board and to new planters. The bulk of the supply has come from Selangor, Pahang and Kedah, as seed fall in the south has been late or in all cases very limited.

The production of clonal seedling stumps for replanting and new planting needs is one of the Department's main functions and involves a considerable amount of work and organisation. As can be judged from the fact that so far this year over 18 million seeds have been collected, germinated, and transplanted, this work alone involves the preparation of over 500 acres of land.

The Department, in conjunction with officers of the Rubber Research Institute and the Replanting Board, is always on the lookout for new sources of seed supply, and during the quarter four new areas were approved by the R.R.I. as potential seed suppliers.

On the East Coast, replanting is of minor importance as the acreage of rubber is relatively small and holdings are considerably younger than those in the west coast States. The demand here is for new planting, and heavy demands for land are being received. It is estimated that only about 4,000 acres will be cleared and planted this year, but there are strong indications that next year this figure will be doubled and may even be trebled now that clonal seedling stumps are more easily obtainable and budgrafting more understood.

In Kedah, where there are extensive areas of illegally planted rubber of low-yielding strains, an attempt has been made to bud as much as possible and some 3,500 yards of budwood has been used. In addition, 31,600 clonal stumps were supplied. In the same State, demonstration plots of one *relong* (.71 acre) each have been established in the "common fields" attached to three of the resettlement areas mentioned in the last Quarterly Report, and soil surveys of the areas have been completed. A further two areas have been preliminarily surveyed and an attempt will be made to plant all five common fields early next year.

LATEX.

The collection of latex from smallholders continues to make slow progress in those parts of the country where it has been established. One new collection centre was opened at Sik in Kedah, bringing the total in that State to six. The sale of smallholders' latex to Malayan American Plantations Ltd. in Kedah gave 1,623 *pikuls** of dry rubber valued at \$178,890. The latex collecting centre at Jasin, Malacca, purchased the equivalent of 157.7 *pikuls* of dry rubber from smallholders and 304.8 *pikuls* from estates.

* 1 *pikul* = 133½ lb.

The scheme in operation in the Taiping area of Perak is now working at maximum capacity and no further storage facilities are available. A total of 465,547 lb. dry rubber content was collected from 12 stations, a considerable increase over the 125,564 lb. D.R.C. collected last quarter.

Changkat Kinding Estate purchased 120.76 *pikuls* of latex from small-holders.

There are now three centralised processing factories in Perak, two previously established at Kumbal Batu and Menora and a new one opened at Changkat Chermin during the quarter. About four *pikuls* of rubber are dealt with daily in these factories.

Padi.

1954-55 SEASON.

Wet Padi.

The final figures show that 842,990 acres was planted with padi and yielded 253,082,000 *gantangs* (equal to 398,560 tons of rice) as compared with 808,760 acres and 253,974,000 *gantangs* (399,960 tons of rice) in the previous season.

The smaller crop during the 1954-55 season was due to drought conditions in the main padi areas of the north and flood conditions on the East Coast and in the extreme south of the Federation.

Results from the large number of extension manurial trials which were put down on cultivators' own lands have been very gratifying, and increases of over 100 *gantangs* (gallons) per acre have been obtained in all States and Settlements except Malacca, where the increase was about 75 *gantangs* per acre, and the coastal and Budu areas of Pahang where increases were of the order of 70 *gantangs* and 67 *gantangs* per acre respectively. An increase of 100 *gantangs* per acre is economic even with manures costing about \$30 per acre and padi selling at \$12/- per *pikul* (the Government guaranteed minimum price).

Dry Padi.

The area planted was 48,100 acres which gave a yield of 7,645,000 *gantangs* (equal to 12,030 tons of rice) as compared with 37,230 acres and 5,213,000 *gantangs* (8,210 tons of rice) in the 1953-54 season.

MAIN SEASON 1955-56 CROP.

Wet Padi.

Dry weather, especially in the north of the Federation, during the months of July and August delayed planting of the main crop, but more favourable conditions during September enabled the cultivator to make considerable progress, and by the end of the quarter the overall situation was that planting, although a little late, was rapidly approaching schedule and the new crop was growing well.

The main effect of this dry spell, which was felt more severely in Kedah, Perlis, Kelantan and Trengganu, was that a number of nurseries were damaged, cultivation was late and, in parts of Kedah, ploughing had to be done twice. The delay in getting the land prepared in time has resulted in large numbers of over-age padi seedlings being transplanted, and in Kedah alone it is estimated that one-third of the coastal plain padi fields have been planted with such seedlings.

The worst affected nurseries were in Trengganu and parts of the coastal district of Pahang where dry nurseries are commonly used. Here the drought resulted in a loss of nurseries and many had to be re-sown.

The majority of these damaged and lost nurseries have been replaced by short-medium term Malayan varieties, but in Province Wellesley, Taiwan varieties have been used. During the quarter, distribution of seed padi amounted to 10,203 *gantangs* of selected seed and 3,051 *gantangs* of unselected seed; the latter figure includes distribution of dry padi. In Malacca, 60 padi seed farms are being established during the current season, 40 of these are sited in the coastal region and will distribute the new selection Nachin 57, and 20 are in the inland areas for multiplication of the variety Serendah Kuning 3.

In Negri Sembilan, the demand for selected Serendah Kuning seed, especially No. 5011, is increasing. Apart from the Department's sales, amounting to some 400 *gantangs*, large quantities are reported to have been purchased or exchanged from the cultivators conducting extension trials.

In central Province Wellesley, where it is usual to plant an off-season padi crop, the cultivators earlier agreed to plant the main crop with Taiwan varieties instead of the normal Malayan varieties. By this means it is hoped to get planting back to schedule. It is estimated, however, that only 50 to 60 per cent of the total area will in fact go down to Taiwan, but those planters who have decided not to plant this variety have sown early nurseries of short-medium Malayan strains, so that the 1956 harvest is not expected to be too late.

Lack of interest in padi planting is reported from the inland districts of Perak and Selangor, all parts of Negri Sembilan except the Jelebu district, and in parts of Johore and Pahang. This lack of interest is mainly due to the improved price of rubber coupled with the fall in padi and rice prices over the past year.

At the end of the quarter, the total area of land planted with wet padi amounted to 412,029 acres out of 848,000 acres expected to be planted; the position, expressed as a percentage of land to be planted in the main producing areas, being as follows:-

Perlis	61.5
Kedah	79.3
Penang & P.W.	46.9
Perak	40.1
Kelantan	27.0

Dry Padi.

The acreage planted by the end of the quarter amounted to 48,077 acres out of an estimated area of 53,501 acres expected to be planted.

In the Besut district of Trengganu some 600 acres of dry padi land has been converted to wet padi through the extension of the Angga Irrigation Scheme.

OFF-SEASON CROP, 1955.

In Central District of Province Wellesley, as a result of the agreement between the padi cultivators and the administration not to supply irrigation water, so as to permit essential maintenance work on the distribution drainage canals to be carried out, the acreage dropped to 4,355 as compared with 6,800 last year. Of this 4,355 acres, 209 acres had to be abandoned due to water shortage and the remaining area gave a yield of only 215 *gantangs* per acre as compared with 306 *gantangs* per acre in 1954.

In north Province Wellesley, where irrigation is not normally provided, the acreage fell from 2,454 to 1,553, mainly due to shortage of rainfall, and the average yield dropped to 240 *gantangs* per acre as compared with 290 *gantangs* per acre last year.

The pilot off-season project in Kelantan resulted in a failure owing to abnormally dry weather and heavy pest damage, the average yield from the 30 acres being only 83 *gantangs* per acre.

THE USE OF FERTILISERS.

As a result of the numerous successful fertiliser trials carried out on cultivators' lands during the past two years, interest in the use of fertilisers is growing in all the main padi growing areas. Large-scale distribution is now routine procedure in Perlis, Kedah, parts of Province Wellesley, Kelantan and, lately, Trengganu.

In Kedah, 89,200 *gantangs* of bat guano have been sold during the quarter as compared with 50,000 *gantangs* in the corresponding period last year and 99,500 *gantangs* in the period July to September, 1953.

In Trengganu, the cultivators in the Besut district have become so fertiliser conscious that they went to the extent of buying subsidized fertilisers from the South Kelantan Malays who were prepared to sell at a profit to themselves. This demand has now been satisfied by making available subsidized fertilisers in Trengganu itself.

In Kelantan, sales of fertilisers under the subsidized scheme amounted to approximately 116 tons by the end of the quarter. This is rather less than in the corresponding period of last year, but was due to dry weather delaying cultivation.

The practice of manuring padi nurseries with sulphate of ammonia (which is an undesirable practice as it tends to promote soft growth) appears to be spreading in Kedah, and many cultivators consider that good results

may be obtained by applying rock phosphate when over-age seedlings have to be used.

Manurial trials carried out on cultivators' lands in Penang last season have stimulated such interest that a new agency has been established in Bayan Lepas. By the end of the quarter, two tons of Christmas Island rock phosphate had been sold to planters who had never used fertiliser before.

During the 1955-56 season the Department is again undertaking a vast programme of manurial investigational-demonstration trials on cultivators' own lands, the target being 2,500, of which 1,088 have already been started. These trials have been laid down in all States and Settlements. The trials vary from simple manure v. no-manure types to more complicated types such as the typical six-plot $O\ P_1\ P_2\ N\ NP_1\ NP_2$ type.

Subsidised fertiliser schemes, making use of the funds provided by the Federal Government under the Rice Committee recommendation, are now in operation in Kelantan, Trengganu and Malacca. In Malacca, distribution to individual padi cultivators is undertaken by the Rural Councils (all of which are elected bodies) and cultivators are required to meet only half the cost, \$15 per acre, after next padi harvest. By the end of the quarter, the Department had distributed to Rural Councils sufficient basal mixture (PK) for 2,163 acres, and over 50 per cent of this had been re-distributed to cultivators.

In other States and Settlements during the quarter, a total of 247.65 tons of fertilisers was distributed through Departmental sources.

MISCELLANEOUS.

The Padi Cultivators (Control of Rent and Security of Tenure) Ordinance, which was passed by the Federal Legislative Council in April, has been implemented to-date only in the States of Kedah and Perlis.

In Kedah, owing to various administrative difficulties, the Ordinance could not be brought into effect efficiently at the proper time, and in spite of postponing the gazetted closing date for registration until 30th September, only 2,336 agreements had been registered; this is estimated to be about five per cent of the total number of tenants. In Perlis, 128 agreements have been registered and the rent fixed for first class land at 6 *naleh**, second class 5 *naleh* and third class 3 *naleh* of padi per *relong* (.71 acre).

The Agricultural Economist has now extended his activities to Kedah, Perlis, Province Wellesley and Kelantan, and field work has been started to provide factual information on land utilisation and land tenure. The Krian Survey is practically complete.

The State Agricultural Officer, Kedah, has carried out a census of padi areas in that State.

In Pahang, the developmental area at Paya Besar has been extended to an additional 100 acres, making 150 acres in all. The whole of this area is worked by machinery.

All States and Settlements entered exhibits for the All-Malaya Padi Competition held by the Malayan Agri-Horticultural Association in August.

1 *naleh* = 16 *gantangs* (gallons)

The main prizes went to Penang—one first and one second; Perak, Selangor and Kedah had one second and one third each, and Pahang had one third.

In addition to The All-Malaya Competition, State annual padi competitions were held in Malacca, Pahang, Johore, Selangor and Perak.

Fruit.

Kelantan, Trengganu and Johore have enjoyed a good fruit season with heavy crops of durians and rambutans. Prices, as is usual with heavy

In addition to the All-Malaya Competition, State annual padi concerned. In Negri Sembilan, only langsung and mangosteen have yielded well, and these fruits have been exported to Singapore in quantity. Malacca has enjoyed a good durian season, but the fruits although plentiful have been below standard size. The Selangor season has been erratic.

Mandarin oranges, for which it was a very fine season at Segamat, Johore, are now popular in Muar and a block of approximately 50 acres has been established at Parit Bakar under the Rubber Replanting Scheme. These oranges sell for \$50 to \$60 per *pikul*.

The growing of bananas between rows of newly planted rubber trees continues to increase in Negri Sembilan, and it is estimated that some 140 acres of new plantings have been established this season.

Following a small manurial demonstration on rambutans in Province Wellesley North, 1½ tons of mixed fertiliser was ordered by smallholders through the Department.

The supply of budded plants from Departmental sources is still insufficient to meet demand, although 11,239 such plants were distributed during the quarter.

In Perak, the four *kampong* (village) fruit nurseries have made considerable progress and 2,753 plants were successfully budded. The first commercial nursery in the same State, run by a Chinese at Sungei Siput, is now producing about 1,000 plants per month.

Pineapple.

The area under this crop has expanded by some 390 acres in Johore and 150 acres in Selangor, and in the latter State a further 330 acres of land has recently been alienated. It is pleasing to note that growers are taking notice of the recommendations made by the Department regarding manuring, spraying with Bordeaux mixture and thinning out. In Johore, 40 acres of smallholders' land at Sungei Burong has been replanted and the plants sprayed with Bordeaux mixture and manured with an NPK mixture; the results are reported to be very good. Another grower, on a trial half-acre plot, has, as a result of manuring, increased his yields by 500 fruits per acre per crop and the fruit weight by 1.2 lb: this is equal to an estimated increase of \$156 per acre per crop nett profit. Demonstrations carried out at Meru in Selangor have resulted in smallholders thinning out their holdings.

Steady progress has been made with the Pekan Nanas Pineapple Smallgrowers Co-operative Society in Johore. About \$10,000 share capital has been raised and two second-hand lorries have been purchased for transport of fruit from the fields to Pekan Nanas. From there, the fruits are taken to the canneries by a haulage company, but members' interests will be watched by the Society during the grading at the canneries.

At Selabak, in Lower Perak, the Drainage and Irrigation Department has completed one main drain and work is in progress on the outlet drain. Planting material for 50,000 Singapore Canning pines was supplied to smallholders in this area during the quarter. This is the first step in establishing new areas for the supply of pines to the local cannery.

Coconut.

There was a small drop in the price received by smallholders for copra during the quarter to \$22 per pikul. New planting is still being carried out, chiefly in Johore on 112 acres. In the same State, 45 acres of smallholders' land has been replanted. Cultivators in the Triang area of Mersing, Johore, have been supplied with 10 cwt. of a special NPK mixture at a subsidised rate.

In Trengganu, a small coconut oil extractor has been purchased and erected by a Malay in the Kemaman district. An average of 200 gal. of coconut oil per month is being produced.

Coffee.

Only two States—Johore and Selangor—are going ahead with this crop. In the former State, some 100 acres is established at the new village of Kampong Hobong and growers have taken 34 cwt. of an NPK mixture at a subsidised price. In Selangor, 50 acres of land has now been planted at Merbau Sempak.

Over 20,000 seedlings were distributed from the Department's nurseries during the quarter, the bulk of these being in Selangor.

Food Crops, Vegetables and Tobacco.

Off-season production of vegetables from the padi fields of Malacca ceased once the rice crop was sown. The bulk of the crop was sold in Singapore. In Sekinchang, Selangor, only 1,655 acres was planted this year as compared with 2,965 acres in 1954. There was, however, an increase in the acreage under tobacco and soya beans, but with a corresponding loss in the acreage under maize. Eight acres of gingelly (*Sesamum indicum*) was grown in the Indian and Chinese areas of Sekinchang.

At the weekly fair at Ajil, in Trengganu, the Department displays and sells selected vegetable seeds. Seeds of long beans, brinjal and amaranth find a ready market.

In Johore, 51½ tons of mixed fertiliser was sold at a subsidised price to cultivators in new villages from Departmental sources.

Supplies of vegetables from Cameron Highlands have been well maintained during the period under review. Here, the Japanese Succession type of English cabbage is not proving too successful, except on the newer lands of the Mensum river, as it tends to grow leggy and produce small heads, but Canadian Wonder climbing French beans have become very popular in the Bertam Valley area. Seeds of this variety were originally supplied by the Department.

A shortage of tapioca in Province Wellesley during the quarter resulted in three factories having to be closed temporarily.

Livestock.

Pigs.

Total distribution of Middle White weaner stock during the quarter numbered 68 boars and 68 gilts, the stud farm at Cameron Highlands supplying about half the stock, mainly to breeders in Pahang, Penang and Kedah. The number of services given by boars owned by the Department totalled 255. In Penang, the demand for the use of the Department's boars has fallen off as there are now a large number of locally-owned Middle White boars. Pig price in that Settlement dropped during the quarter to \$87 per *pikul*, but the price of weaners remained steady at about \$150 per *pikul*; this has affected those pig keepers who merely buy weaners for fattening.

A new pig farm has been started at Rasah in Negri Sembilan, and at present there are some 300 animals.

At the Municipal Abattoir, Malacca, a total of 7,041 pigs were slaughtered, of which 3,997 were Middle White cross-breds. A very similar state of affairs is to be found in Penang.

In Perak, in the pig/fish project at Sungei Siput, the fish ponds are paying well but the pigs show no profit at a selling price of about \$90 per *pikul*.

POULTRY.

The stock imported by the State Agricultural Officer, Selangor, earlier in the year from the United Kingdom has done well and a few birds have already commenced laying at just under five months of age. Arrangements have been made to import hatching eggs from the U.K. and Denmark during the next quarter.

The Rural and Industrial Development Authority's hatchery scheme at Setapak, Selangor, has been closed down until hatching eggs from the new importations become available.

In Penang, 1,250 pellets of Hexoestral for caponisation were distributed by Departmental staff during the quarter.

There are large Chinese hatcheries in most of the western States which produce considerable numbers of birds each quarter. For instance, in Malacca a total of 35,000 chicks and 40,000 ducklings were produced, and in

Perlis, 18,000 ducklings. The mortality amongst these birds is often extremely high, owing to the purchasers not giving the young birds sufficient attention during the first few weeks of their life.

Interest in pure-bred birds is less marked in several parts of the country, especially in places where large eggs do not command an enhanced price. In and around the large towns however there is still a good and only partially satisfied demand for pure-bred birds.

Totals of 646 pure-bred birds and 2,878 hatching eggs were distributed from Departmental sources during the quarter.

GOATS.

The British Alpine herd at Ayer Itam, Penang, has been passed as free of Melioidosis and quarantine restrictions have now been lifted. A total of 14 services was performed by the pure-bred British Alpine at Bukit Mertajam, Province Wellesley, and 13 services by the 13/16 Saanan buck owned by the Penghulu Bakri of Johore.

Mechanisation.

Over 500 acres of wet and dry padi land and 250 acres of dry land have been cultivated by tractors under the control of the Department during the quarter. In addition to these acreages, large areas of land have been cultivated in Perak and Province Wellesley by private contractors.

In Province Wellesley, rotovators have been used for the preparation of the padi fields at a charge of \$35 per acre. This implement does a good job, but some cultivators have complained that rotovation tends to reduce yields.

In Johore, Department tractors were used to prepare 50 acres of padi land at a subsidised rate of \$15 per acre, an operation which was not popular with everyone as the prospect of some hand labour being dispensed with led to sabotage of the tractors during the night.

Three power threshers (Turner) were used in the Panchang Bedina area of Selangor during harvest time and dealt with 1,698 *pikuls* of padi as compared with 1,471 *pikuls* in 1954.

In the Padang Rengas area of Perak, where hitherto most of the padi cultivation had been done by buffalo, this year over one-third of the area was cultivated by a contractor with a tractor and a Kraus 7 harrow at rates of about \$30 per acre. The planters prefer to tap rubber and pay the contractor rather than plough with buffaloes.

With a view to reviving interest in the use of buffaloes for padi cultivation, buffalo ploughing matches were held at Lambor, Parit and Lubok Merbau in Perak during the quarter and aroused much interest. Some of the ploughing reached a high standard.

Rural Agricultural Education.

During the past years, considerable attention has been paid to the very important task of educating the smallholders of the country in agricultural practices. No hard and fast methods or syllabi have been laid down

and each State or Settlement decides upon its own programme of work according to the needs of its cultivators.

There are certain educational methods which are common to all States and Settlements, such as visits to Agricultural and Padi Test Stations by groups of people, e.g. school teachers, pupils, *ketua kampung* (headmen) and other similar bodies, lectures by officers of the Department of Agriculture to groups of cultivators at the local mosques, weekly fairs or in new villages, and demonstrations on subjects of common interest, such as padi seed selection, rubber replanting, budgrafting and other similar subjects.

In addition to these, the Department assists with the Civics Courses, normally run by the Department of Information, by the way of lectures and demonstrations.

Short-term general agricultural courses are now run regularly in Perak, Pahang and Selangor. The duration of these is from 14 to 21 days, with an average attendance of between 15 to 20 students. In Kedah and Negri Sembilan, a different type of course is run in that one or two families are given a course lasting two to three months.

Specialised courses are organised whenever it is necessary to impart some important agricultural information, such as budding of fruit and rubber trees, rubber replanting methods, padi planting and so on.

Young Farmers' Clubs have been organised in Selangor and Province Wellesley. In the latter Settlement, where there are five Clubs for Chinese based on new villages, a Central Advisory Committee has recently been set up to organise and see that they are properly run. Attempts in the same Settlement to organise Young Farmers' Clubs amongst the Malay population have not been successful, although in Selangor they have done fairly well.

To give some idea of the extent of the Department's activities in connection with rural education, the following figures are of interest:-

PERIOD.

Quarter ending Sept., 1955.

No. of lectures given:	38
No. of demonstrations given:	11 (excluding padi trials)
Organised visits to Department Stations:	14
Civics Courses:	10
Short Agricultural Courses:	8
Long Agricultural Courses:	2
Specialised courses—rubber:	3
padi:	1
budding:	1

This list does not include routine visits to school gardens.

Of the Short Agricultural Courses, two call for special mention, that at Pekan in Pahang and the other at Cheras in Selangor.

At the Agricultural Training School, Pekan, three courses were conducted during the quarter and 40 students were catered for. Instruction consists not only of practical and technical work at the school itself, but includes visits to central rubber nurseries, the Paya Besar Padi Test Station (mechanical cultivation of padi) and Pahang Tua Padi Test Station. Considerable attention is being given to following up the activities of trainees when they return to their *kampongs*.

At Cheras in Selangor, five courses catering for a total of 71 youths were held during the quarter. The demand for these courses is so great that the so-called rest periods between main courses have had to be filled with supplementary courses. There is little doubt that these courses are filling a real need and are fully appreciated by those attending. In September, 30 more places were offered and 67 applications were received.

A Japanese padi film was shown in Johore and Malacca during the quarter. In Malacca the show was attended by Malay and Chinese padi cultivators and local leaders from all parts of the Settlement. After the film show, imported Japanese buffalo ploughs were exhibited and a practical demonstration of seed separation treatment was given together with a talk on padi varietal work by the Botanist.

At Cameron Highlands, demonstrations on the proper methods of picking tea and pruning the bushes were given to labourers working on Chinese-owned smallholdings.

In Pahang, with the object of inducing smallholders to replant their old rubber holdings under the replanting scheme, a team of Department of Agriculture, Rubber Research Institute and Rubber Replanting Board officers visited 14 centres and gave talks and explained the scheme to over 240 interested smallholders.

Agricultural shows, excluding the Malayan Agri-Horticultural Exhibition, were held as follows:- Sungei Bakap, Province Wellesley, one day; Seremban, Negri Sembilan, two days; Batu Pahat, Johore, three days; and Kuantan, Pahang, two days. In addition, two agricultural shows, organised by Local Councils, were held in Trengganu and officers of the Department acted as judges.

Newsletters were issued during the quarter in Kedah (14th issue), Selangor and Johore, in the last two States for the first time. In Selangor, two letters were issued, a general one and a special rice letter for the coastal areas.

Review.

Directory of Wheel and Track-Type Tractors Produced Throughout the World.

Food and Agriculture Organization of the United Nations, Rome, 1955. Pp. 371, mimeographed with stiff covers. Price 15 shillings.

The need for comprehensive lists of tractors has long been felt by agricultural engineers and machinery dealers, and official tractor testing stations and commercial publishing houses have, from time to time, produced reference lists and trade directories. Most of these publications have dealt with the tractors manufactured in one particular country and few, if any, have attempted to present a comprehensive world list. The "*Directory of Wheel and Track-Type Tractors Produced Throughout the World*" does not give such a complete coverage as its title suggests (for example, no Russian tractors are listed) but it gives details of 523 types manufactured in 13 countries.

The arrangement of the *Directory* is simple: wheeled and tracked tractors are contained in different sections and each section is sub-divided into categories, based upon the maximum rated horsepower of the engine. An index, classified under manufacturers' names and addresses, is included and it is therefore possible to find information on all tractors in a given horsepower category, or details of any particular make and model, with the minimum of trouble.

The *Directory* is written in English, French and Spanish, and details, which are set out in tabular form, of each model are given in both English and Metric system measurements. The details given include leading dimensions, weight distribution, turning radius, engine specification and output, fuel consumption at maximum power, maximum drawbar pull and speeds in each gear: tyre sizes and pressures are given in the case of wheeled tractors and ground bearing pressures in the case of tracked tractors.

In most reference lists, the price of the tractor is omitted on the grounds that prices are subject to rapid changes and the publication would soon become obsolete, but the compilers of the *Directory of Wheeled and Track-Type Tractors* have included the current *ex works* price of the majority of models listed. This is a very valuable feature of the *Directory*: even if prices should fluctuate within the next few years, the prices shown are a useful guide which enables a preliminary selection to be made before manufacturers are approached for detailed quotations.

It is unfortunate that no reference is made to the general characteristics of the tractors listed. It is not, for example, possible to differentiate between a general purpose four wheeled and a row crop tricycle tractor unless, as in the case of the John Deere 40 Standard and 40 Tricycle, the model designation is revealing: similarly, it is not possible to determine whether or not a tractor is, or can be, fitted with a hydraulic lift or a three-point hydraulic linkage. For this reason the *Directory* will not replace the conventional reference books, many of which contain photographs and very detailed specifications, but will remain a handy reference list from which a preliminary selection of makes and models can be noted for more detailed study.

Departmental Notes.

Promotions.

Mr. K. Kanapathy, Assistant Chemist, was promoted to Chemist with effect from the 10th June, 1955.

Mr. A. Johnston, Plant Pathologist, was promoted to Senior Plant Pathologist with effect from the 13th July, 1955.

Che. Omar bin Buyong, Pupil Agricultural Officer, was promoted to Agricultural Officer with effect from the 12th August, 1955.

Mr. Lee Sin Fook, Agricultural Assistant, was promoted to Agricultural Officer, on probation, with effect from the 11th September, 1955.

Mr. Van Thean Kee, Pupil Botanist, was promoted to Botanist with effect from the 23rd September, 1955.

Appointments.

Mr. G. S. Keeping, Agricultural Officer, was appointed State Agricultural Officer, Negri Sembilan, with effect from the 11th August, 1955.

The Secretary of State for the Colonies has appointed the following officers to be Agricultural Officers in the Agricultural Branch of Her Majesty's Oversea Civil Service with effect from the 19th August, 1955:- Mr. C. R. Raper, Mr. R. J. R. Barrett, and Mr. D. L. Stacey.

Mr. A. L. Barcroft, Agricultural Officer, was appointed State Agricultural Officer, Pahang, with effect from the 11th September, 1955.

Mr. J. L. B. Hitchcock, Agricultural Officer, was appointed State Agricultural Officer, Trengganu, with effect from the 11th September, 1955.

Mr. P. G. Coleman, Agricultural Officer, was appointed to act as State Agricultural Officer, Kelantan, with effect from the 19th September, 1955.

Mr. H. J. Simpson, P. J. K., Senior Agricultural Officer, was appointed to act as Chief Field Officer with effect from the 26th September, 1955.

Statistical.

MARKET PRICES

July to September, 1955.

Rubber.—On eight occasions during the period under review the Singapore price of R.S.S. No. 1 (f.o.b. in bales, buyer) was above \$1.50 per lb.—a price that had not been exceeded since November, 1951.

July commenced with the price at 117.75 cents and, apart from a drop on the 8th and 9th, there was a gradual increase to 137.625 cents per lb. on the 29th. The average price in July was 127.35 cents.

On the 2nd August the price was 141.50 cents per lb., and by the 4th it had reached \$1.54, the highest price quoted during the quarter. During the remainder of the month the price fluctuated between 133.75 and 153.75 cents, to give an average for August of 143.20 cents per lb.

The price was above \$1.50 per lb. on four occasions during September but was down to \$1.38 on the last day of the month. The average price for September was 147.39 cents per lb.

The prices quoted above are the noon prices for rubber as reported by the Singapore Chamber of Commerce and they have been taken from the Monthly Statistical Bulletin of the Federation of Malaya.

The average prices paid for smallholders' rubber during the quarter at three towns in the Federation of Malaya are shown in Table I.

Table I.
Average Monthly Prices Paid by Local Dealers for
Smallholders' Rubber, July to September, 1955.

(Dollars per picul of 133 1/3 lbs.)

Grades.	Taiping, Perak.			Seremban, Negri Sembilan.			Batu Pahat, Johore.		
	July	Aug.	Sept.	July	Aug.	Sept.	July	Aug.	Sept.
Smoked Sheet No. 1 ..	129.14	138.03	140.64	132.12	140.70	143.18	—	—	—
Unsmoked Sheet ..	93.50	109.86	115.40	93.78	100.38	102.44	100.48	114.38	115.38
Scrap ..	60.91	52.09	51.44	62.80	57.91	58.59	40.08	40.00	39.76

This Table has been compiled from statistics supplied by the Registrar of Statistics, Federation of Malaya.

Tea.—The Registrar of Statistics, Federation of Malaya, reports that 1,348,173 lb. of made tea was produced during the quarter, to give a total production of 3,976,771 lb. during the first nine months of 1955.

The average prices paid for Ceylon teas at the sale held in Colombo on the 27th September, 1955, as quoted in the Weekly Tea Market Report of the Colombo Brokers' Association, were as follows, in rupees per lb.: High Grown Teas (4,000 ft. and above) 2.28; Medium Grown Teas (2,000 to 3,999 ft.) 1.92; and Low Grown Teas (below 2,000 ft.) 2.33.

Palm Oil.—The London prices for palm oil during the quarter were, in Malayan dollars per ton:— July 632.14; August 627.85; September 651.42. The average price paid in London during the second quarter of 1955 for oil shipped by the Malayan Oil Palm Pool, f.o.b. ex-installation in Malaya, was \$659.32.

Derris.—The price of derris remained at \$110 per picul.

Table II.
Singapore Prices of Various Agricultural Products.

(Dollars per picul)

Date	Copra, Sundried	Coconut oil*	Pepper, F.A.Q. Muntok white	Pepper, Gen. Muntok white	Garnier, Cube, No. 2	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
1955								
4th July ..	27.50	44.50	177.00	187.00	44.00	12.75	17.25	15.50
11th July ..	27.50	45.50	178.00	188.00	44.00	13.00	17.25	15.00
18th July ..	27.75	45.50	176.00	186.00	44.00	13.00	17.25	15.00
25th July ..	27.25	44.50	172.00	182.00	44.00	12.87½	17.25	15.50
2nd Aug. ..	26.00	43.25	168.00	178.00	44.00	12.75	17.25	15.00
8th Aug. ..	25.75	42.50	169.00	179.00	44.00	12.75	17.25	14.50
15th Aug. ..	26.50	43.00	170.00	180.00	45.00	12.75	17.25	15.50
22nd Aug. ..	26.25	42.50	163.00	173.00	45.00	12.75	17.25	15.50
29th Aug. ..	27.00	43.50	163.00	173.00	45.00	12.75	17.25	15.50
5th Sept. ..	27.25	43.00	161.00	171.00	45.00	12.75	17.25	15.50
12th Sept. ..	26.50	42.50	161.00	171.00	45.00	12.75	17.50	15.50
19th Sept. ..	27.25	43.25	161.50	171.50	45.00	12.75	17.50	15.50
26th Sept. ..	27.25	44.00	163.50	173.50	46.00	12.75	17.50	15.50

* F.O.B. in second-hand drums.

The above prices are taken from the weekly reports of the Singapore Chamber of Commerce.

FEDERATION OF MALAYA

PRODUCTION OF PALM OIL AND KERNELS.

(In long tons as declared by Estates)

MONTH	PALM OIL		PALM KERNELS	
	1954	1955	1954	1955
January ..	4,143	4,093	1,139	1,124
February ..	3,908	3,997	1,066	1,081
March ..	4,442	4,854	1,210	1,300
April ..	4,674	4,630	1,228	1,221
May ..	5,251	4,152	1,396	1,076
June ..	4,188	5,135	1,114	1,256
July ..	4,580	4,802	1,162	1,238
August ..	4,694	5,128	1,236	1,348
September ..	4,319	5,073	1,157	1,269
October ..	4,333		1,154	
November ..	4,642		1,273	
December ..	4,776		1,336	
Total ..	53,950	(41,864)	14,471	(10,913)

In September, 54 estates were in production out of a total of 61 oil palm estates.

MALAYAN AGRICULTURAL EXPORTS, APRIL—JUNE, 1955.

Product	NET EXPORTS IN TONS.			
	Year 1953	Year 1954	Apr.-June, 1954	Apr.-June, 1955
Arecanuts ..	11,580	5,511	546	4,764
Coconuts, fresh † ..	88,315 †	94,433 †	28,125 †	34,720 †
Coconut oil † ..	60,779	78,507	18,980	18,872
Copra † ..	9,751 *	67,472 *	11,811 *	14,041 *
Copra cake ..	59,129 *	40,520 *	10,376 *	13,861 *
Gambier, all kinds ..	160 *	134 *	25 *	16
Palm Oil ..	47,579	48,908	14,096	12,064
Pineapples, canned ..	17,368	21,533	6,644	8,279
Rubber ¶ ..	572,792 ¶	582,991 ¶	129,354 ¶	144,594 ¶
Sago,—flour ..	28,444	27,980	9,542	6,504
Sago,—pearl ..	5,896	5,122	1,059	1,061
Sago,—raw ..	27,246 *	27,021 *	5,569 *	3,818 *
Tapioca,—flake ..	123 *	49	158	126
Tapioca,—flour ..	7,362 *	4,555 *	683 *	859 *
Tapioca,—pearl ..	5,474	7,865	2,229	1,812
Derris ..	10	16	6	7
† Copra equivalent ..	90,781	88,943	19,594	17,320

¶ production (Federation of Malaya).

† hundreds in number.

* net imports.

FEDERATION OF MALAYA RUBBER PRODUCTION.

(In long tons, dry weight)

MONTH	ESTATES		SMALLHOLDINGS (ESTIMATED)		TOTAL	
	1954	1955	1954	1955	1954	1955
January ..	30,278	29,260	19,014	26,033	49,292	55,293
February ..	25,354	28,497	17,913	21,928	43,267	50,425
March ..	24,556	27,465	17,452	24,874	42,008	52,339
April ..	24,749	24,155	15,339	20,415	40,088	44,570
May ..	27,572	27,355	18,585	22,331	46,157	49,686
June ..	26,873	27,497	16,236	22,841	43,109	50,338
July ..	30,970	30,238	22,931	25,647	53,901	55,885
August ..	30,826	30,650	21,576	23,571	52,402	54,221
September ..	30,067	31,274	23,371	24,764	53,438	56,038
October ..	29,405		20,724		50,129	
November ..	31,798		22,925		54,723	
December ..	30,313		24,164		54,477	
Total ..	342,761	(256,391)	240,230	(212,404)	582,991	(468,795)
Total 1953 ..	341,117		231,675		572,792	

This Table has been compiled from statistics published by the Registrar of Statistics, Federation of Malaya.

Production on smallholdings (estates of less than 100 acres) is taken as the total of purchases from smallholders reported by licensed dealers.

FEDERATION OF MALAYA
PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE.
(in tons)

Month	COPRA PRODUCTION				COCONUT OIL PRODUCTION		COPRA CAKE (POONAC) MANUFACTURED	
	Estates (a)		Smallholdings (estimated)		Oil Mills		Oil Mills	
	1954	1955	1954	1955	1954	1955	1954	1955
January	3,123	2,674	9,470	4,297	12,593	6,971	8,837	5,528
February	2,789	2,797	9,616	8,366	12,405	11,163	7,798	7,753
March	3,072	2,975	11,482	7,726	14,554	10,701	8,721	7,368
April	2,993	3,021	9,922	7,478	12,915	10,499	8,961	6,165
May	3,803	3,619	10,128	7,630	13,931	11,249	8,098	7,399
June	3,763	3,748	12,175	10,534	15,938	14,282	8,158	8,017
July	4,112	3,955	11,850	12,311	15,962	16,266	8,582	8,538
August	3,886	4,188	11,237	10,275	15,123	14,463	8,480	8,580
September	3,431	3,745	10,631	9,511	14,112	13,256	8,501	9,259
October	3,069		11,160		14,229		8,014	5,403
November	2,942		8,854		11,796		7,296	5,184
December	2,831		7,770		10,601		7,354	4,602
Total	39,864	(30,722)	124,295	(78,128)	164,159	(108,850)	96,800	61,568
	..							(43,133)

Notes:—1. The above Table has been compiled from statistics published by the Registrar of Statistics, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

(a) Includes copra equivalent of sales of fresh nuts by estates.

FEDERATION OF MALAYA PADI STATISTICS

Summary of Acreages and Production, Season 1954-1955.

TOTAL WET AND DRY PADI								
State or Settlement (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Production	
	acres	per cent. of total	acres	per cent. of (2)	acres	per cent. of (2)	Padi (5) gantangs (⁰⁰⁰ s)	per cent. of total
Perlis	49,040	5.6	—	—	49,040	100.0	15,607	6.1
Kedah	284,910	32.4	8,130	2.9	276,780	97.1	104,544	40.6
Kelantan	175,160	19.9	2,390	1.4	172,770	98.6	44,484	17.3
Trengganu	56,170	6.4	2,480	4.4	53,690	95.6	9,792	3.8
Penang & P. Wellesley	39,230	4.5	1,030	2.6	38,200	97.4	8,982	3.5
Perak	114,590	13.0	190	.2	114,400	99.8	26,897	10.4
Selangor	48,290	5.5	100	.2	48,190	99.8	17,489	6.8
Pahang	41,400	4.7	7,360	17.8	34,040	82.2	6,400	2.5
Negri Sembilan	30,900	3.5	550	1.8	30,350	98.2	10,960	4.2
Malacca	30,930	3.5	760	2.5	30,170	97.5	10,618	4.1
Johore	9,270	1.0	830	9.0	8,440	91.0	1,694	.7
Total, Main Crop	879,890	100.0	23,820	2.7	856,070	97.3	257,467	100.0
Off-Season Crop, 1954	11,200	—	180	1.6	11,020	98.4	3,260	—
Total, 1954-1955	891,090	—	24,000	2.7	867,090	97.3	260,727	—
Total, 1953-1954	845,990	—	23,560	2.8	822,430	97.2	259,187	—

Acreage to nearest 10 acres.

Rice production to nearest 10 tons.

Conversion rate: 635 gantangs padi = 1 ton rice (i.e. milling recovery = 63 per cent.)

FEDERATION OF MALAYA PADI STATISTICS

Summary of Acreages and Production, Season 1954-1955.

Wet Padi.

296

State or Settlement (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Average Yield per Acre				Production			Remarks (9)
	acres	per cent. of total	acres	per cent. of (2)	acres	per cent. of (2)	Padi (5)	per cent. of main season average yield	Rice (6)	Padi (7)	per cent. of total	Rice (8)		
													tons	
Perlis	48,890	5.9	—	—	48,890	100.0	319	103.2	1,123	15,580	6.2	24,540	4,500 acres partially damaged by drought.	
Kedah	282,930	34.0	8,130	2.9	274,800	97.1	379	122.7	1,334	104,233	41.7	164,150	6,250 acres damaged by drought; 1,010 acres by pests and diseases; and 870 acres by sea water.	
Kelantan*	146,260	17.5	2,370	1.6	143,890	98.4	274	88.7	964	39,435	15.8	62,100	2,350 acres damaged by floods and 20 acres by elephants.	
Trengganu	46,550	5.6	2,350	5.0	44,200	95.0	193	62.5	679	8,518	3.4	13,410	2,300 acres damaged by floods and 50 acres failed due to late planting.	
Penang and P. Wellesley	39,210	4.7	1,030	2.6	38,180	97.4	235	76.1	827	8,980	3.6	14,140	900 acres abandoned due to drought and 130 abandoned due to the Emergency.	
Perak	110,440	13.3	110	.1	110,330	99.9	238	77.0	838	26,264	10.5	41,360	60 acres attacked by "Penyakit Merah" and 50 acres damaged by sea water.	
Selangor	48,270	5.8	100	.2	48,170	99.8	363	117.5	1,278	17,487	7.0	27,540	100 acres destroyed by floods.	
Pahang	38,970	4.7	7,270	18.6	31,700	81.4	194	62.8	683	6,147	2.5	9,680	7,160 acres destroyed by floods; 70 acres by drought; and 40 acres damaged by rats and drought.	
N. Sembilan	30,900	3.7	550	1.8	30,350	98.2	361	116.8	1,271	10,960	4.4	17,260	550 acres failed due to floods, late planting and pest damage.	
Malacca	30,910	3.7	760	2.5	30,150	97.5	352	113.9	1,239	10,616	4.2	16,720	490 acres damaged by flood; 150 by pests; 90 by shortage of water; and 30 acres of padi bore empty grains.	
Johore	9,250	1.1	830	9.0	8,420	91.0	201	65.0	708	1,693	.7	2,670	830 acres destroyed by flood.	
Total, Main Crop	832,580	100.0	23,500	2.8	809,080	97.2	309	100.0	1,088	249,913	100.0	393,570		
Off-Season Crop, 1954	10,410	—	160	1.5	10,250	98.5	309	100.0	1,088	3,169	—	4,990	160 acres destroyed by pests.	
Total, 1954-1955	842,990	—	23,660	2.8	819,330	97.2	309	100.0	1,088	253,082	—	398,560		
Total, 1953-1954	808,760	—	23,350	2.9	785,410	97.1	323	99.7	1,141	253,974	—	399,960		

* Amended.
Acreage to nearest 10 acres.
Rice production to nearest 10 tons.
Conversion rate: 635 gantangs padi = 1 ton rice (i.e. milling recovery = 63 per cent.)

FEDERATION OF MALAYA PADI STATISTICS

Summary of Acreages and Production, Season 1954-1955.

Dry Padi.

297

State or Settlement (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Average Yield per Acre			Production			Remarks (9)
	Acres	per cent. of total	Acres	per cent. of (2)	Acres	per cent. of (2)	Padi (5)	per cent. of main season average yield	Rice (9)	Padi (7)	per cent. of total tons	Rice (8)	
Perlis	150	.3	—	—	150	100.0	174	108.1	612	27	.4	40	20 acres destroyed by pests. 130 acres damaged by floods.
Kedah	1,980	4.1	—	—	1,980	100.0	157	97.5	553	311	4.1	490	
Kelantan*	28,990	61.1	20	.1	28,880	99.9	175	108.7	616	5,049	66.8	7,950	
Trengganu	9,620	20.3	130	1.4	9,490	98.6	134	83.2	472	1,274	16.9	2,010	
Penang and P. Wellesley	20	.1	—	—	20	100.0	80	49.7	282	2	—	—	80 acres damaged by drought. 50 acres failed due to floods; and 40 acres damaged by drought and elephants.
Perak	4,150	8.7	80	1.9	4,070	98.1	156	96.9	549	633	8.4	1,000	
Selangor	20	.1	—	—	20	100.0	116	72.0	408	2	—	—	
Pahang	2,430	5.1	90	3.7	2,340	96.3	108	67.1	380	253	3.4	400	
N. Sembilan	—	—	—	—	—	—	—	—	—	—	—	—	
Malacca	20	.1	—	—	20	100.0	133	82.6	468	2	—	—	
Johore	20	.1	—	—	20	100.0	51	31.7	180	1	—	—	
Total, Main Crop	47,310	100.0	320	.7	46,990	99.3	161	100.0	567	7,554	100.0	11,890	
Off-Season Crop, 1954	790	—	20	2.5	770	97.5	119	73.9	419	91	—	140	20 acres destroyed by birds.
Total, 1954-1955	48,100	—	340	.7	47,760	99.3	160	99.4	563	7,645	—	12,030	
Total, 1953-1954	37,230	—	210	.6	37,020	99.4	140	100.0	497	5,213	—	8,210	

* Amended.

Acreage to nearest 10 acres.

Rice production to nearest 10 tons.

Conversion rate: 635 gantangs padi = 1 ton rice (i.e. milling recovery = 63 per cent.)

METEOROLOGICAL SUMMARY, MALAYA, JUNE, 1955.

LOCALITY	AIR TEMPERATURE DEGREES FAHRENHEIT						EARTH TEMPERATURE		RAINFALL						BRIGHT SUNSHINE				
	Means of		Absolute Extremes				At 1 foot of	At 4 feet of	Total		Most in a day	Number of days					Total	Daily Mean	Per cent.
			Highest	Lowest	Min.	Max.						Highest	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.			
	A.	B.	Max.	Min.	A and B	Highest	Lowest	Min.	Max.	Highest	in	mm.	in	mm.	in	mm.	hr.	hr.	
Ipoth, Perak	92.9	73.1	83.0	96.3	66.5	84.2	75.3			7.59	192.8	1.97	10	9	1		212.85	7.09	
Kuala Lumpur, Selangor	90.3	73.5	81.9	95.5	70.4	83.2	75.8			5.80	147.3	2.30	11	10	7	2			
Sitiawan, Perak	91.3	72.8	82.1	96.3	69.0	83.5	76.3	86.1		1.64	41.7	0.71	8	7	4		218.15	7.27	
Kuantan, Pahang	88.6	72.9	80.7	93.0	70.0	79.2	76.3	82.9		8.82	224.0	2.95	15	11	7	6	1	161.75	
Bayan Lepas, Penang	88.4	74.2	81.3	92.2	71.9	81.2	77.0			5.78	146.8	1.34	7	6	1		196.45	6.55	
Malacca	88.3	73.1	80.7	92.0	70.2	81.7	75.9			5.49	141.4	1.78	16	14			180.60	6.02	
Mersing, Johore	88.1	72.0	80.1	91.5	69.9	77.2	74.0			9.14	232.2	3.32	14	13	2		195.00	6.50	
Alor Star, Kedah	88.3	73.9	81.1	92.9	71.5	80.8	76.3			12.05	306.1	4.01	11	11			162.35	5.41	
Kota Bharu, Kelantan	88.2	74.4	81.3	92.5	71.6	82.0	77.7	85.9		7.65	194.3	2.20	16	15	8	1	181.35	6.07	
K. Trengganu, Trengganu	88.4	73.0	80.7	92.0	70.7	80.0	75.4			3.29	83.6	1.49	11	10	4		181.35	6.05	
Singapore	87.9	76.5	82.2	91.1	72.0	81.0	82.0			7.26	184.4	2.04	16	12	4		156.25	5.21	
HILL STATION.																			
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	74.0	54.3	64.1	76.0	44.0	69.0	62.0			4.40	111.8	1.01	12	12			164.40	5.48	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JULY, 1955.

LOCALITY	AIR TEMPERATURE DEGREES FAHRENHEIT							EARTH TEMPERATURE		RAINFALL							BRIGHT SUNSHINE	
	Means of		Absolute Extremes				At 1 foot of	At 4 feet of	Total	Precipitation Most in a day	Number of days					Total	Daily Mean	Per cent.
			A. Max.	B. Min.	Means of A and B	Highest Max.					Lowest Min.	Lowest Max.	Highest Min.					
	Precipitation .01 in or more	Precipitation .04 in or more					Thunderstorm	Fog morning obs.						Gale force 8 or more				
Ipoh, Perak	92.0	72.3	82.1	95.7	67.6	85.4	76.4		in mm.	in	1.77	20	15	1	1		hr. 215.50	6.95
Kuala Lumpur, Selangor	89.2	72.5	80.9	92.6	69.5	80.0	74.1		4.60	116.8	1.75	13	7	1	8		216.30	6.98
Sitiawan, Perak	90.7	72.0	81.3	94.1	69.6	84.6	74.9	84.6	2.39	60.7	0.79	15	10	5			219.35	7.07
Kuantan, Pahang	89.5	71.8	80.7	92.4	69.8	86.8	73.6		8.04	204.2	1.50	16	15	11	4		196.95	6.35
Bayan Lepas, Penang	87.1	73.6	80.3	90.1	71.0	82.4	75.6		12.98	329.7	2.48	18	17	3			207.05	6.68
Malacca	87.3	72.3	79.8	89.5	70.1	83.1	74.2		3.34	84.8	0.86	16	12				207.25	6.69
Mersing, Johore	86.7	70.6	78.7	90.7	68.0	78.7	72.4		10.00	254.0	2.72	17	13	2		1	239.40	7.72
Alor Star, Kedah	88.5	73.1	80.8	91.4	71.5	84.9	75.2		2.73	69.3	1.58	15	10	1			268.90	8.67
Kota Bharu, Kelantan	88.4	73.2	80.8	90.2	70.9	86.1	75.6	87.4	1.82	46.2	1.07	12	5	5			240.35	7.75
K. Trengganu, Trengganu	88.6	72.2	80.4	90.7	70.0	79.6	74.9		4.92	125.0	1.79	10	10	4			160.00	5.16
Singapore	86.4	75.2	80.8	90.1	72.0	81.6	80.6		6.34	161.0	4.17	11	5	2				
HILL STATION.																		
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	73.1	55.0	64.1	77.0	49.0	68.0	59.0		8.70	221.0	1.78	18	17				177.05	5.71

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, AUGUST, 1955.

LOCALITY	AIR TEMPERATURE DEGREES FAHRENHEIT					EARTH TEMPERATURE		RAINFALL										BRIGHT SUNSHINE	
	Means of		Absolute Extremes			At 1 foot	At 4 feet	Total	Most in a day	Number of days					Total	Daily Mean			
			Highest	Lowest	Min.					Lowest	Max.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm			Fog morning obs.	Gale force 8 or more	
	A. Max.	B. Min.						in mm.	in	mm.	in	mm.	in	mm.	hr.	hr.			
Ipoh, Perak ..	90.6	72.2	81.4	67.9	82.8	74.6		7.04	173.8	1.15	18	17	1		180.90	5.83			
Kuala Lumpur, Selangor ..	88.0	72.3	80.1	69.2	80.4	74.0		8.39	213.1	2.88	18	14	7	7	185.40	5.98			
Sitiawan, Perak ..	89.7	72.1	80.9	69.0	84.2	74.8	85.6	5.76	146.3	1.36	11	8	5		157.00	5.06			
Kuantan, Pahang ..	87.7	71.3	79.5	69.0	80.0	73.4	81.8	5.35	135.9	1.29	16	15	2	1	197.85	6.38			
Bayan Lepas, Penang ..	87.0	73.9	80.5	70.3	82.8	80.4		4.18	106.2	1.12	13	9			145.85	4.70			
Malacca ..	86.2	72.3	79.3	70.0	82.5	74.6		5.00	127.0	1.60	19	12	1		157.10	5.07			
Mersing, Johore ..	86.0	70.9	78.5	68.8	81.8	72.8		7.08	179.8	2.33	18	16			214.80	6.93			
Alor Star, Kedah ..	87.6	73.3	80.5	69.9	82.4	75.9		12.45	316.2	5.10	19	16	1		203.65	6.57			
Kota Bharu, Kelantan ..	88.3	73.2	80.7	71.0	85.0	75.9	86.7	4.71	119.6	1.77	13	11	5		190.10	6.13			
K. Trengganu, Trengganu ..	87.4	72.3	79.8	70.4	80.0	76.3		5.91	150.1	1.57	14	11	1						
Singapore*																			
HILL STATION.																			
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	72.5	55.3	63.9	77.0	50.0	67.0	60.0	9.73	247.1	1.72	21	21			121.95	3.93			

Compiled from Returns supplied by the Malayan Meteorological Service.

* Records incomplete due to move of Station to new airport.